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Draughtsmen, before Negotiating with Government Departments in connection with any post, please communicate with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's Square, London, S.W.1. G 758

TENDERS.

CITY OF BIRMINGHAM WATER DEPARTMENT.

BARTLEY RESERVOIR.

EXTENSION OF TIME FOR SUBMISSION OF TENDERS.

Notice is Hereby Given that the time for the delivery of Tenders for the above work, advertised in this paper on 26th December, 1924, and 2nd January, 1925, has been extended from noon on Monday, 26th January, 1925, to noon on Monday, 9th February, 1925.

J. H. BROADLEY, Secretary.

Water Department,
Council House,
Edmund Street,
Birmingham.
8th January, 1925. G 882

COUNTY OF LONDON.
REPAVING OF WESTMINSTER BRIDGE.
The London County Council invites

Tenders for the Repaving with Wood Blocks, and subsequent maintenance, of the CARRIAGEWAY of WESTMINSTER BRIDGE.

Persons desiring to Tender may obtain the Form of Tender and Contract, Specification and Bill of Quantities on application to the Chief Engineer, at the Old County Hall, Spring Gardens, S.W.1, upon payment of the sum of £3, by cheque or draft, to the order of the London County Council. This amount will be returnable only if the Tenderer shall send in a *bona fide* Tender which is not subsequently withdrawn. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after Four p.m. on Monday, 2nd February, 1925, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council.
G 914

THE PACIFIC CABLE BOARD,
Queen Anne's Chambers, Westminster, invite British Manufacturers to

Tender for the Manufacture and LAYING of 3625 nautical miles of SUBMARINE TELEGRAPH CABLE, between BAMFIELD (Vancouver Island) and FANNING ISLAND, and also for the MANUFACTURE and LAYING of 2171·8 nautical miles between FANNING ISLAND and SUVA, FIJI, making a total length of 5796·3 nautical miles.

Each cable to be Tendered for separately, and the Specifications include alternative types of conductor for each cable, namely, (1) a continuously loaded core and (2) an unloaded core. Modifications in the electrical characteristics, dimensions and type of loaded conductor, will receive due consideration and full particulars of the core tendered for, including the electrical characteristics proposed in the laid cable must be given when tendering.

Forms of Contract, Specification and Tender may be obtained on and after Thursday, the 22nd of January, upon application at the Offices of the Board, or to the Board's Engineers, Messrs. CLARK, FORDE & TAYLOR, 4, Great Winchester Street, E.C., at whose offices charts showing the proposed route of the cables may be inspected.

Applications must be accompanied by a deposit of Ten Guineas, which will be returned on receipt of a *bona fide* Tender.

Tenders must be addressed to the PACIFIC CABLE BOARD, Queen Anne's Chambers, Westminster, and must be delivered there, on or before Noon. of Thursday, the 26th of February, sealed and marked "Tender for Cable."

The Board do not bind themselves to accept the lowest or any Tender. G 917

The Director-General, INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES
BATTERY OF DROP STAMPS, Electric Motor Driven.
Tenders due on the 27th January, 1925.
Tender Forms obtainable from above. G 938

For Sale, Cold Rolled STEEL STRIP 2⅝ in. wide, 20/21 S.W.G., made from open hearth steel 63/80 carbon, 5 Erichsen test guaranteed. If sheared, would be suitable for packing case or cotton tie hooping, etc. Offers invited for lots of 50, 100 or 250 tons. For Tender Forms and particulars apply to DIRECTOR-GENERAL, India Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E.1. G 937

THE GREAT INDIAN PENINSULA RAILWAY COMPANY, 48, Copthall Avenue, London, E.C.2, invite

Tenders for:—

1. STEELWORK for Bridges ... Fee £1
2. BIB COCKS, etc. ... ... Fee 2s. 6d.

Tenders are due by Eleven a.m. on 27th January, 1925. Tender forms obtainable at above address. Fees not returnable. G 952

YOUGHAL (CO. CORK) URBAN DISTRICT COUNCIL.

Tenders are Invited for the SUPPLY of about 7 miles of 8-in. CAST IRON WATER MAIN. Specification and Form of Tender will be supplied by the undersigned on payment of Two Guineas, which will be refunded on receipt of a *bona fide* Tender.

B. O'FLYNN, B.E.,
Engineer,
Trinity Chambers,
South Mall.
Cork.
G 916

SOUTHAMPTON CORPORATION WATER-WORKS.

OTTERBOURNE PUMPING STATION.

TO PUMPING ENGINE MANUFACTURERS.

The Corporation invite

Tenders for the Manufacture, DELIVERY, ERECTION, SETTING TO WORK, TESTING and MAINTAINING for a period of six (6) months of 2 TRIPLE EXPANSION PUMPING ENGINES, WELL and FORCE PUMPS, etc., each set to be of a capacity of 6 million gallons per day of 24 hours, against a head of 280 feet.

Plan of Existing and Proposed Engine Houses, etc., with Specification, Conditions of Contract and Form of Tender, may be obtained from Mr. R. C. RONDA, Waterworks Engineer, 21, Shirley Road, Southampton, upon production of the Borough Treasurer's receipt for a deposit of £5 5s.

Deposits will be returned after the Council have dealt with the Tenders to Contractors who have submitted *bona fide* Tenders.

Sealed Tenders endorsed "Tender for Pumping Plant, Otterbourne Waterworks," must be delivered at the Town Clerk's Office, on or before the 16th February, 1925.

No pledge is given to accept the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.
6th January, 1925. G 859

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED,
Are prepared to receive

Tenders for the Supply of:

1. STRUCTURAL STEELWORK (Yard Plant).
2. STEELWORK for Bridges (T.D.B. Railway).

Specifications and Forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W.1.

Tenders addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked: "Tender for Structural Steelwork (Yard Plant)" or as the case may be, must be left with the undersigned not later than 12 Noon on Friday, the 13th March, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of each Specification.

Copies of the Drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. ROBERT WHITE & PARTNERS, of 3, Victoria Street, Westminster, S.W.1.

A. MUIRHEAD,
Managing Director.
91, Petty France, S.W.1.
14th January, 1925. G957

APPOINTMENTS OPEN.

LOUGHBOROUGH COLLEGE.
Loughborough,
Leicestershire.

DR. H. SCHOFIELD, M.B.E., PRINCIPAL.

DEPARTMENT OF AUTOMOBILE ENGINEERING.

Applications are Invited for the POSITION of HEAD OF the AUTOMOBILE ENGINEERING DEPARTMENT. Candidates should be graduates of a British University, and have had practical experience in the design and manufacture of Automobiles. The scale of salary ranges from £450 to £650 by annual increments of £25, and the commencing salary will depend upon the qualifications and experience of the applicant.

All applications, with copies of not more than three recent testimonials, should be forwarded before January 28th to the REGISTRAR, from whom any further particulars may be obtained. G 926

Wanted, Competent Accountant capable taking charge of Office and acting Secretary to Engineering Firm; engineering knowledge preferable. Good prospects right man.—Address, stating education, qualifications, age and salary, G 884, Offices of ENGINEERING.

Wanted, for Engineering Works employing about 150 men at Leicester, COMMERCIAL MANAGER, thoroughly experienced in all departments, must be capable to control Drawing Office, Sales Office and correspondence, and have sound works experience. Preference to man experienced in Road and Quarry Plant, Elevating, Conveying, and Crushing Machinery. State fully experience, where and when gained, age, salary required.—Address, G 885, Offices of ENGINEERING.

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Works Superintendent WANTED; experience Petrol and Paraffin Engine Building, efficient production methods and handling of men. London District.—Address, stating age, experience and salary required, G 918, Offices of ENGINEERING.

Assistants (Two) Required by the GOVERNMENT OF CEYLON for service in the Architectural Office of the PUBLIC WORKS DEPARTMENT for a period of three years with possible permanency. Salary £500, rising to £560 a year by annual increments of £30, and thence (if appointment is made permanent) to £960 a year, payable locally in rupees at the Government rate of exchange of 15 rupees to the £. Free passages. Candidates, preferably unmarried, aged 26-30, must have passed the examination for Associate Membership of the R.I.B.A. or for the Membership of the Society of Architects, and have had good general architectural experience.—Apply at once by letter, stating age, qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting M/12945. G 944

Assistant Engineers (4) REQUIRED for the GOLD COAST GOVERNMENT Central Province Railway Construction for a tour of 12 to 18 months' service, with possible extension. Salary £480, rising to £720 a year by annual increments of £30. Field allowance of £96 a year whilst carrying out duties in the Colony. Free passages and liberal leave on full salary. Candidates, not over 40 years of age, must be fully trained Civil Engineers, and be proficient in the use of the Transit and Level. Must have ability to do ordinary draughting and compiling estimates, and be able to set out work and generally supervise erection of concrete and steel work. One of the four Engineers required must be a proficient Draughtsman.—Apply, at once, by letter, stating age, qualifications and experience to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W.1, quoting M/12449. G 934

Civil Engineers (2) Required by the GOVERNMENT of SIERRA LEONE for the PUBLIC WORKS DEPARTMENT for two tours of from 12 to 18 months' service, with possible extension. Salary, £480 for the first three years of service, and then £510, rising to £720 a year by annual increments of £30, and thence to £920 a year by annual increments of £40. Free passages and quarters, and liberal leave on full salary. Candidates, aged 25 to 35, must have served articles with a corporate Member of the Institution of Civil Engineers, and have passed the examination qualifying for A.M.I.C.E., or hold equivalent professional qualifications. Must be good draughtsmen, capable of designing and carrying out buildings, bridges and other engineering structures, and of taking out quantities and preparing detailed plans and estimates. Must be competent to execute Surveys and to lay out and construct roads, and have had experience as Civil Engineers on the construction of roads, buildings and other Public Works.—Apply at once, stating age, qualifications and experience to—THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/13305. G 933

Executive Engineer REQUIRED by the GOVERNMENT of SIERRA LEONE in the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' continuous residential service. Salary £600 a year. Free quarters and passages, and liberal leave on full salary. Candidates, aged 28-35, should have served articles with a Member of the Royal Institute of British Architects, and have passed the examination qualifying for Associate Membership of that Institute, or possess the diploma of some recognised college which is accepted by that Institute as exempting candidates from taking the examination of the Institute. Must be first-class Draughtsman, capable of designing and carrying out buildings, taking out quantities, preparing details and specifications, and must be competent to execute building surveys, set out buildings and lay out roads.—Apply at once by letter, stating age, qualifications and experience to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/13190. G 891

A Firm of Export Engineers handling the export of Motor Cars, Lorries and Accessories, have a VACANCY on their Staff for an ASSISTANT ENGINEER having a thorough knowledge of such business. Previous experience of a similar nature essential. Salary £400 per annum.—Reply, BOX A.E. 254, c/o DAWSONS Advertising Agency, 118, Cannon Street, London, E.C.4. G 897

Engineer Wanted to supervise construction of overhead transmission lines in England. Previous experience essential. Send full particulars, age, experience, references, and salary. Vacancy also for Assistant.—Write, BOX, 280, SELLS' Advertising Offices, Fleet Street, E.C.4. G 913

Resident Engineers Required for Works re-organisation on the Thames, having experience with pile driving, reinforced concrete construction and heavy foundations, to start immediately.—Address, stating age, experience, and salary required, G 910, Offices of ENGINEERING.

Electric Traction Engineer, WANTED, by large manufacturing Firm, ENGINEER with specialised knowledge of design and manufacture of electric railway motors. Must have ability and practical experience in determination of motor requirements for specific electric traction projects. Good remuneration and excellent prospects offered. Only ambitious and progressive men with practical experience need apply. State full particulars, salary required and earliest date commence.—Address, G 900, Offices of ENGINEERING.

Resident Engineer Required for new sea defence works and buildings. Must have had similar experience, and possess sound knowledge of handling and working of large plant; competent to set out works, take levels, make surveys, supervise Contractor's work, check quantities, make detail drawings, prepare specifications, and supervise and control labour. Thorough understanding of good work essential. Salary £7 7s. per week. State age, qualifications and experience, with testimonials.—Address, G 830, Offices of ENGINEERING.

Wanted Immediately, Competent ENGINEER having extensive experience in the design of large Valves, Sluice Gates, etc., for Hydro-Electric and Irrigation Works, etc. The duties would include supervising designs, preparing estimates, conducting correspondence, interviewing clients when necessary, and generally controlling the technical and commercial side of the Department in a large and old established Concern specialising in this class of work. Only first-class men possessing the necessary qualifications will be considered. Applicants should state age, experience and salary required.—Address, G 915, Offices of ENGINEERING.

Assistant Engineers, (two), REQUIRED by the PUBLIC WORKS DEPARTMENT, FEDERATED MALAY STATES for four years' service with possible permanency. Salary $440 a month, rising to $880 by annual increments of $25, plus a temporary non pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No Income Tax at pre ent in Malaya. Free passages provided. Candidates, age 26 to 35, preferably unmarried, must have received a good theoretical training, preferably at a University or an Engineering College recognised by the Institution of Civil Engineers, or have completed articles with a Civil Engineer of good standing, and have passed the Examination for Associate Membership of the Institution of Civil Engineers. Possession of an Engineering or Science degree preferred. In addition to pupilage, must have had at least one year's practical experience in the design and execution of works of some considerable magnitude. A knowledge of modern road making and maintenance is desirable.—Apply, at once, by letter, giving brief details of qualifications and experience, and stating age and whether married or single, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting clearly at head of application M/13324. G 907

Oil Engine Designer Wanted by prominent oil engine manufacturer in the United States. Must be qualified to design both horizontal and vertical two-stroke cycle engines of the airless injection cold-starting type, in sizes of 60 to 500 H.P.—Address, giving full particulars of experience, education, age and salary, BOX 268, MCGRAW-HILL PUBLISHING CO., LTD., 6/8, Bouverie Street, London. G 943

Draughtsman Required by the GOVERNMENT OF NIGERIA for two tours of not less than 12 nor more than 18 months' service. Free passages and quarters and liberal leave on full salary. Outfit allowance of £60 on first appointment. Salary £600, rising by annual increments of £30 to £720 and thence by annual increments of £40 to £800 a year. Candidates, aged 25 to 35, should be A.R.I.B.A., and have had experience of hospital and general building work and have had good experience of quantities.—Apply, at once, by letter, stating age, qualifications and experience to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W.1, quoting M/13205. G 945

First-Class Draughtsman WANTED for light work, experience in coach building, aircraft or similar work preferred.—Address, stating full particulars and salary required, G 814, Offices of ENGINEERING.

A Prominent Firm of Steel Structural Engineers, in Manchester district, REQUIRES a SENIOR DRAUGHTSMAN, able to design and make working details for Buildings and Bridges. State age, full particulars of experience and salary required.—Address, G 836, Offices of ENGINEERING.

THE SALVAGE OF A FLOATING DOCK.

ON May 28 last year a floating dock belonging to Messrs. Philip and Son, Limited, of Dartmouth, which was lying in Dartmouth Harbour, was requisitioned for docking a large German sailing ship. The German vessel was got into the dock without trouble, and the dock was being raised when it took a cant sideways. The shoring poles gave way, allowing the ship to fall over into contact with the dock side, and this caused the dock to capsize completely and to sink to the bottom of the harbour. The ship floated away unharmed.

The appearance of the floating dock as it lay in the harbour before the incident which we have related is shown in Fig. 1, below. Immediately after the accident the owners got into touch with the Falmouth Docks and Engineering Co., Limited, who dispatched their salvage officer, Captain Bayford, to Dartmouth to see what could be done. Captain Bayford found, on arrival, that the dock was lying in 7½ fathoms L.W.O.S.T., the slope of the bottom giving her a list of 6 ft. to starboard and a fore-and-aft declivity of 5 ft., her position being as shown in Figs. 2 and 3. Divers had made a preliminary survey and reported that the tank-top was badly fractured amidships on the starboard side. The upper side of the centre tower on the same side was also smashed, and the upper works generally had been damaged by the falling over of the vessel in the dock.

After a short consideration of the possibilities of the case, the Falmouth Docks and Engineering Company made a contract with the owners to salve the dock, and sent their salvage vessel Ringdove's Aid to Dartmouth with a crew for the work. The salvage vessel was moored over the sunken dock, and divers proceeded to make a further survey with a view to ascertaining the exact state of affairs. The dock, which was 260 ft. long by 63 ft. wide, contained eight tanks, as shown in Fig. 4, together with wing tanks and a centre drain tank. Very little information was available concerning its construction, as it was about forty years old and no drawings could be found. It had, moreover, only recently come into the possession of Messrs. Philip and Son, Limited, who could therefore do little more than make a sketch plan showing the approximate location of the control valves, with indication as to their uses. Nearly all the valve handles were inside the pontoon and inaccessible, while those handles which were operated from the outside were found by the divers to have mostly been broken away or distorted beyond use by the accident. With such scanty information, the methods for the recovery of the wreck had to be decided on.

In view of the damaged condition of the tank-top and the side walls, also the unknown position of the control valves, it was decided to recover the buoyancy necessary to refloat the dock by using compressed air in the four corner tanks and the centre drain and wing tanks. With all these tanks full of air, it was estimated that a gross buoyancy of 1,624 tons would be obtained and that, after deducting the estimated weight of the dock and making certain allowances, there would be a net surplus buoyancy of 133 tons. Subsequent information, however, came to hand which showed the actual capacity of the tanks to be as follows:—

	Tons.
No. 1, combined port and starboard ...	603
No. 2, " " ...	579
No. 3, " " ...	584
No. 4, " " ...	594
Wing tanks	238
Centre drain	371

so that, by filling Nos. 1 and 4 tanks, the wing tanks and the centre drain with air, a gross buoyancy of 1,806 tons would be obtained. The weight of the dock was 1,287 tons, or, allowing 150 tons for the weight of water displaced by the material, its submerged weight requiring to be lifted was 1,137 tons, the surplus buoyancy being therefore 669 tons. Deducting 10 per cent. of the gross buoyancy for water left in the tanks, and deducting a further 185 tons on the assumption that the centre drain might give only half the estimated buoyancy, there was left a surplus of 304 tons of lifting power.

The main tanks had originally been built and used with three subdivisions in each tank, and a control valve to each compartment. Subsequently, however, the two intermediate valves were abolished and only the valve into the centre drain retained. It was therefore assumed, quite reasonably, that there was proper communication between the three compartments of each tank, and on this assumption connections for air pipes were fitted to the outside compartments. Other pipes for the escape of the displaced water were fitted to the inside compartments and reached from the tank top to within an inch of the tank bottom. Similar air and water pipes were fitted to both sides of the centre drain, which was divided into separate port and starboard sides by a central longitudinal bulkhead. This work was completed by June 22 last, within about three weeks of the sinking of the dock. The air compressors were started up and run for several days continuously, except for intervals to allow divers to descend and stop leaks which became very evident. After a week of this work, it was discovered that air pumped into any tank was flowing freely all over the dock, and operations were suspended as the contractors felt that it would not be possible to control the dock should she start to lift. The attempt had showed up many leaks, and notably that air could pass from the main tanks to the engine room and thence to the sea through the suction pipes of the dock's pumps. The pump discharges were plated over by the divers, and the strainer of a large drain valve was removed and the valve cemented up.

The possibility of devising some method of dealing with the situation was thoroughly discussed by Captain Harrison and Captain Bayford, the salvage officers of the Salvage Association and of the Falmouth Docks and Engineering Company respectively. It was clear that the methods which could be adopted were largely governed by condition of the tank top, which was seriously damaged owing to being crushed by one of the bilge stools. There were, moreover, other serious fractures in the tank top plating, and the expense of extensive patching which would be needed to make the plating good was considered unwarranted, if anything else could be done. Furthermore, there was no certain knowledge as to whether the valves between the tanks and the centre drain were open or shut. It was subsequently found that the valves between No. 4 tank and the drain were the only ones closed. All things being considered, and with the risk of the dock capsizing being borne in mind, it was decided that the best plan would be to try and recover the buoyancy of the side walls by pumping the water out, and to recover the buoyancy of the tank by compressed air as before.

The damage to the starboard side walls due to the ship falling over from the blocks was considerable, the tops of the walls being crushed in. The outside plating had also been damaged by the ship freeing herself when the dock sank. All this damage had to be patched by divers, who had the further job of cutting holes in the top of the sidewalls, forward and aft, to enable the side walls to be pumped out by submersible pumps. The pumps were fixed and suction pipes put down as low as possible, a matter of some difficulty owing to the existence of internal platforms and the presence of floating wreckage inside the dock walls. The damaged walls also had to be stiffened internally with struts to resist the unbalanced pressure due to pumping. Great difficulty and danger was encountered by the divers in this work, which necessitated their entry into the side walls through narrow hatchways.

As the first operations had shown that there was a passage of air from the main tanks to the engine room, an attempt was made to get into the latter to search for open valves and cocks. The only way into the engine-room was by the forward tower, and this way was anything but easy or safe, for the entry hatch was barely large enough to admit a diver in dress and helmet. It required the presence of three divers, stationed at intervals in the tower and passage way, to clear the air pipes and life lines. However, an entry was effected and some open valves were found and closed. The pumps were started on July 27, and

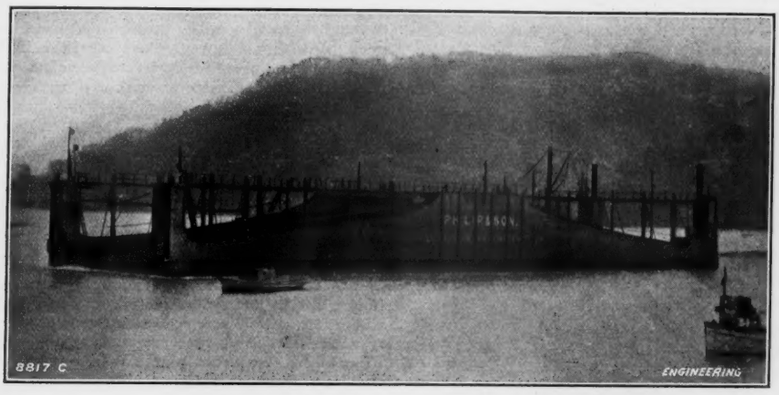
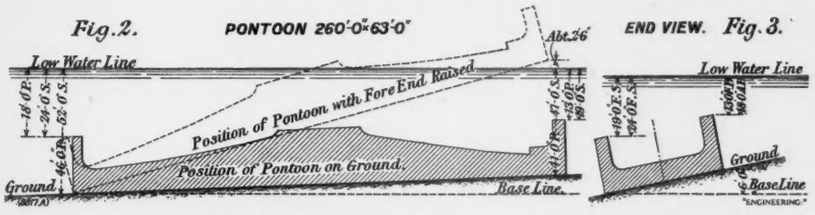
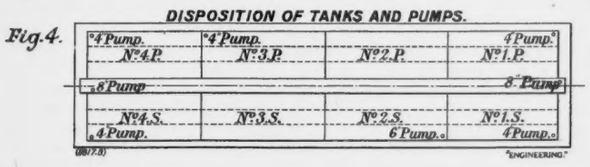


FIG. 1. THE DOCK IN DARTMOUTH HARBOUR.





Valves between tanks 1, 2 and 3 P. and S. open to centre drain. Valves between tanks 4 P. and S. closed to centre drain. Tank 2 starboard badly damaged and patched.

divers were sent down to watch for leaks. On July 30 both the pumps and the air compressor were put on and kept in operation all day. During the afternoon the fore end of the dock lifted something like 4 ft., and later on the dock commenced to list to starboard. As the pumps were unable to make any impression on the water in the side walls, it was decided to abandon this attempt, for it was apparent that there were leaks in the side walls sufficient to render pumping ineffectual. Moreover, air could clearly travel all over the structure, and by naturally going always to the high side it would certainly have caused the whole thing to capsize if sufficient could be got in to lift her.

As a result of this second failure to recover the dock, the contractors put forward to the Salvage Association a recommendation to make a further attempt by adopting pumping instead of compressed air for getting the water out of the main tanks, as they felt from their previous experience that the use of compressed air was unwise. This recommendation was accepted and the Ringdove's Aid, which had been sent back to Falmouth, was ordered last and final attempt to raise the dock before abandoning the work.

On October 3, all being in readiness, a trial run with the pumps was made, the condition of the dock being such that the whole of the main tanks would be pumped out. The side walls, wing tanks, and end towers were open to the sea, so that the water could drain from these as the dock rose. On the pumps being started it was found there was a strong flow of water into the port wing tank through the manhole in the side, which had been left open to allow the water to drain out as the dock rose. All means were tried to find any open valves which might connect this tank with the others, but with no success, and, rather than abandon the attempt, it was decided to close up the manhole and run the risk of lifting the dock with about 100 tons of water locked within it, which might act as a possible capsizing weight.

The next day pumping was started about two and a-half hours before low water. An hour and a-half after the start the fore end of the dock rose quickly but steadily, until the fore-foot was clear of the water. The two pumps connected with the after

FIG. 5. DOCK AFTER RE-FLOATING, SHOWING SUBMERSIBLE PUMPS.

to return to Dartmouth to resume operations. On August 18 the salvage vessel was again moored over the wreck and work recommenced. Divers patched the tank top, and did a very fine piece of under-water work, considering the depth and the strength of the current, by casing in the crushed bilge-stool which had burst through the plating. This particular repair is prominently shown in Fig. 8, page 76. A further entrance into the engine-room was made by the removal of a plate on the forward sill, and during the trials of the pumps divers were able to get into the engine-room and close various cocks and valves between the engine-room and the main tanks. Submersible pumps were installed as shown in Fig. 4, the four 4-in. pumps having a capacity of 100 tons per hour each, the 6-in. pumps having a capacity of 250 tons per hour, and the 8-in. pumps lifting 350 tons an hour each, all against 50 ft. head.

The pumps were started on September 10, but the leaks still held the mastery, and on sending down divers to examine the progress while the pumps were running, it was found that the suction pressure was so great that the patches showed signs of starting away from the plating, and that the air pipes were flattening. It seemed probable that there was not the free communication between the three compartments of the tanks which had been assumed, and the flattening of the air pipes was attributed to the vacuum created in the middle compartment. It was therefore decided to fit a vent pipe to each compartment, and to make a tanks were then started, but after half-an-hour's run one of them failed, and both were stopped. It was found that the fore end of the dock was under perfect control, only needing an occasional run with the pumps to get rid of accumulated leakage. It was therefore decided to keep this end afloat and raise the other end next day at low water after having repaired the faulty pump. The air vents gave complete satisfaction. An hour before low water on October 5 the after pumps were started, and after an hour and a-half of pumping the after end began to rise very slowly. The dock commenced to list to port, but was at once controlled by stopping and starting pumps as required. At the end of two and a-half hours from the commencement of pumping the after sill was clear of water and the dock refloated practically to her light-load line. A very large amount of mud, estimated at 500 tons, had gathered on the top during the four months' submersion, and this was "hydrauliced" off by the fire-hoses of the Ringdove's Aid during the next day.

Several views of the dock, illustrating the nature of the work which has been described, are given in Figs. 5 to 9, above and on page 76. The success which at length attended the protracted efforts of the contractors is highly creditable to all concerned. Salvage work is always hazardous, and the position and condition in which the dock had sunk rendered the work of refloating her extremely difficult, and it was at all times a matter of speculation whether it could be accomplished safely, without the structure collapsing or capsizing. The depth of water in which she lay was considerable, and the force of the tide was so great as to prevent the divers working at times, and always to increase their difficulties. As time went on the accumulation of mud on the tank-top increased the difficulty of finding leaks. The depth of water and its muddiness caused the whole of the divers' work to be carried out practically in darkness, as no submersible light could penetrate the muddy water effectively. Furthermore, the absence of any reliable information about the internal arrangements of the structure made trial and error the only methods by which success could be achieved. The abandonment of compressed air in favour of pumping methods avoided the great structural damage which otherwise would have been necessary to enable the tanks to be separated from each other and from the central drain. The dock was refloated with no structural damage whatever due to the salvage operations beyond the holes cut for the installation of pumps and air pipes, all of which could be easily covered by small patches which would restore the dock to a thoroughly workable condition. Both the owners and the contractors are to be congratulated on a difficult piece of work well carried out.

LITERATURE.

Low Temperature Carbonisation. By C. H. LANDER, D.Sc., M.I.Mech.E., and R. F. MCKAY, M.Sc., M.I.Mech.E. [Benn, 35*s.* net.]

Low Temperature Carbonisation. By S. M. WELLINGTON, A.M.I.E.E. and W. R. COOPER, A.M.Inst.C.E., M.I.E.E., A.I.C. [Griffin, 25*s.* net.]

WHEN coal gas was first made, it was produced in iron retorts, and the carbonisation was therefore conducted at a relatively low temperature. Unfortunately, in those days neither chemistry nor thermometry was so developed that accurate account could be taken either of the actual temperatures attained or of the products of distillation, and the period during which low temperature carbonisation was the standard process passed by, therefore, without yielding any great knowledge that might be available for the problems of to-day. On the other hand, it was found in gas making that a considerably higher yield of gas could be obtained by increasing the temperature, and later on, more bye-products such as sulphate of ammonia. For the time being, therefore, practice abandoned low temperatures in carbonising coal, and showed no disposition to revert to them until the beginning of this century, when the pioneer work of Parker drew attention not only and perhaps not so much to the valuable bye-products of low-temperature carbonisation as to the smokeless fuel that it was Parker's primary object to produce.

At this time there seems no doubt that the great complexity of the problem was not realised. There was, for instance, a general understanding that coals might be coking or non-coking. This was a distinction that was obviously necessary for the purposes of practice, and in regard to it little or nothing was done in the laboratory that went beyond recognising the distinction as a practical man would do. It has since been found that much more is necessary if uniform results are to be produced by the use of coals of varying compositions. The forests that have been fossilised to produce coal appear to have contained trees with the same sort of variety in their chemical composition as can be found in growing trees to-day, and the fossilising process has left the coal with variations as great. It has, therefore been necessary, not for the purpose of using coal but of carbonising it, to enquire much more closely into its composition. Until comparatively recent years this enquiry has been limited to proximate analyses, which determine the proportions of moisture, volatile matter, fixed carbon and ash; ultimate analyses, which specify the proportions in which the constituent elements are found; and determinations of calorific value; with later on a determination of the "coking index," measuring the amount of sand that can be mixed with a fine-ground coal before carbonisation, in order to produce a coke of a standard strength.

All these determinations, except that of calorific

value, though perhaps better than nothing, were under the disadvantage that they were merely conventional, and did not correspond to the properties that actually affected both carbonisation and the subsequent use of the products. It was found accordingly that for judging the suitability of a given coal for such a purpose as low temperature carbonisation it was necessary to have some method of assay that would reveal its behaviour in the temperatures to which it was to be subjected. Methods such as those of Gray and King and of Lessing were accordingly evolved, and threw considerable light on the behaviour of different coals; and by his judicious, patient, and skilful microscopical work Beilby showed how the properties of a blend of coals, neither of which would be suitable by itself for carbonisation at low temperatures, might be made thoroughly satisfactory. All this work has amounted to a considerable advance; but the processes of carbonisation to be practised on such heterogeneous materials have been found to raise an infinity of problems, which at the present time are being attacked vigorously and systematically, but so far have yielded no final practical solution.

That all this work should have been done is due to a realisation, not confined to technical men, that if a way could be found of carbonising coal at low temperatures economically and with practical convenience, it might be a means of abolishing the wasteful and mischievous nuisance of smoke, and of providing within the country a supply of fuel oil, and perhaps also motor spirit. Between the wish to attain these results and the elaboration of the means there has proved to be a wide distance, and the lay world is waiting with more or less impatience until some practical means has been demonstrated. In such circumstances it is plain that any works which deal from a practical point of view with the subject of low-temperature carbonisation must be in the nature of interim reports, and their value will be greater in so far as they enable the reader to master separately the main considerations that enter into the problem in each of its aspects.

The appearance almost simultaneously of the two works named above, following at so short an interval on that of Messrs. McCulloch and Simpkin, is good evidence of the belief that the facts of low-temperature carbonisation need to be brought together into a single volume. It is a great merit of the work of Dr. Lander and Mr. McKay that their work both enables the several aspects of the problem to be considered separately, and presents the result as a stage in technical progress which must go further before it reaches a solution of the great problems with which it is concerned, rather than as a description of processes that have already reached a final form. The right attitude to low-temperature carbonisation was well expressed by Sir George Beilby, not only in the report on the subject published by the Fuel Research Board, but also in an introduction that he contributes to the present volume. He recognises that the subject is of national importance in view of both the purposes that a successful system might attain, but adds the caution that "its physical, chemical, mechanical and economic aspects are so closely interwoven that only after the intimate study of all these aspects ought any serious estimate of its development as a national industry to be attempted." The present work has been written to enable a reader to appreciate the several branches of study that are involved, as well as the chief results already attained. At the cost of a little occasional repetition, the various aspects are treated in separate chapters, and each chapter is very nearly self-contained. Dr. Lander, who succeeded Sir George Beilby as Director of Fuel Research, and Mr. McKay have been associated with the important inquiries of the Fuel Research Board during the last six or seven years, which have taken account not only of the experimental work at the Fuel Research station, but also of the similar work of outside inventors and experimenters all over the world. They are therefore in what Sir George Beilby describes as an almost unique position to have undertaken to write the present book, which, indeed, they did on a request and under some pressure from Sir George himself. A main difficulty of reporting on a complex subject that has not quite emerged from the evolutionary state is to be able to see the wood for the trees. The excellent perspective in which the many aspects of the subject are presented shows that the authors have seen and met this difficulty. The work, indeed, contains both the material for judging of the several aspects of the subject and a clear indication of the way in which they are related to each other.

Messrs. Wellington and Cooper give more attention to the details of new plants, which indeed are lavishly illustrated, and somewhat less to exhibiting a perspective view of the several aspects of the subject. They cover some parts of the same ground as that with which Dr. Lander and Mr. McKay have dealt, though perhaps less completely and systematically. A notable feature in their work is a comparison of estimates of the respective cost of generating electric power in capital power stations by coupling with them low-temperature carbonisation and other plants. Such estimates are necessarily based on wide assumptions, but may be of some interest when such questions are being considered. The book as a whole does not purport to give more than a treatment of the theoretical aspects and descriptions of some systems that have been tried and difficulties that have been encountered. It would therefore not be fair to ask from it a complete account of all that has been done in its subject. It is, however, notable that the book omits to mention either the Gray-King or the Lessing methods of coal assay, which have been so important an addition to the means of estimating the value of coal for the purposes of low-temperature carbonisation, or even the fundamental work of the Fuel Research Board itself.

The Planning, Erection and Operation of Modern Open-Hearth Steelworks. By HUBERT HERMANNS. London: Ernest Benn, Limited. [Price 42*s.* net.]

THE theory of steel making in all its phases has for very many years past formed the subject of papers read before the various English-speaking technical societies. The proceedings for instance of the Iron and Steel Institute, among other societies of this class, contain a large number of such papers, together with the discussions thereon, both the papers and the discussions constituting a very thorough encyclopedia in this respect. The practical side of steel making, embodying such questions as steelworks plant, furnace design and size, types of producers, the suitability of various fuels for working the open-hearth furnace, and so forth, has been dealt with very frequently also, and among the more recent contributions to the Institute's proceedings may be mentioned several on British Siemens furnaces, British steelworks gas-producers, and the recovery of waste-heat in open-hearth furnace practice. All these and other papers, read either before the Institute alone or at joint meetings with other scientific bodies, are of great practical value in the matter of economical manufacture of high grade quality steel. Many other data of equal interest can also be found in technical journals published in this country, in the United States, and on the Continent.

The book with which we are at present concerned has the advantage of forming a handy compendium on the manufacture of open-hearth steel generally, whilst covering more especially what we may term the engineering side of the subject. It is the English translation of a book in German by the same author, which we reviewed in our issue of June 1, 1923; the British editor is Mr. Wesley Austin, of Arrochar. The first pages deal very briefly with the history of the open-hearth furnace and with the metallurgical processes involved; they also give a few statistics on the steel output in this country, the United States and Germany. Following these, the location of a steelworks is considered in detail from the standpoints of raw material and liquid iron supply, the provision of heat and the quick removal of the manufactured steel. The author then draws attention to the location of the various departments with a view to securing a regular sequence in the different operations from start to finish, points which have a bearing both upon the engineering and the economical aspects of steel plant installation and working. The greater part of the information covers details on the furnaces themselves, the gas producers, auxiliary machinery, by-product recovery, waste-heat utilisation, &c. As its title implies, the book is a guide to the laying-down of an open-hearth steelworks to the best advantage, and examples of British, American and Continental installations are referred to and illustrated. A very large number of open-hearth furnaces of different types, both stationary and tilting, are also described and illustrated, together with the gear, equipment and accessory apparatus. The concluding chapters deal with the work carried out for improving the thermal efficiency of open-hearth plant, and refer to the recovery of tar from the gasification plant, the use of richer gases, waste-heat boilers and supervision of the thermal efficiency. The duplex and triplex processes are, also, briefly reviewed. The book will be appreciated as a handy reference guide to the above subjects.

Reverting to the statistical data in the first pages, we find that in Germany the Bessemer steel production exceeded the open-hearth steel output down to the year 1915 inclusive. Taking, further, the eleven years from 1910 to 1920, the production of Bessemer steel in Germany amounted in round figures to 77,000,000 tons, and that of open-hearth steel to 73,000,000, or 4,000,000 tons less. In this country, according to the same table, the open-hearth steel production has gradually exceeded that of Bessemer steel since the year 1895.

THE BASSANO DAM AND IRRIGATION WORKS.

THE construction of the Bassano dam across the Bow River, 83 miles east of Calgary, by the Canadian Pacific Railway Company, has enabled a million acres of prairie land previously looked upon as of little or no use for agricultural purposes, to be placed under irrigation, and thus to become as productive as any other portion of the Dominion. This work, which has entailed the expenditure of several millions of dollars, has been carried out under the supervision of Mr. J. S. Dennis, assistant to the President of the Railway Company and head of the Department of Natural Resources. The work was started about three years prior to the war, and at the outbreak of war the greatest part of the earth-work for the canals, aggregating 20 million cubic yards, had been completed and operations well advanced on the principal structure. The remaining work to be done consisted largely of placing over a thousand small structures, which were mainly wood, and scattered over the irrigable tract covering the greater part of 2,000 square miles.

The quantity of water, as shown by the records of the Dominion Government, is very large, the river receiving the drainage from over 5,000 square miles above Bassano. It has a heavy spring flow, while the highest stages are reached between June 15 and August 15, thus an ample supply is furnished through the crop season. At other times it affords an adequate quantity for conveyance through the main canal to the storage reservoir located within the irrigable tract. This provision of storage for a part of the irrigable area in the vicinity of the farms is valuable as an assurance against certain classes of operation troubles.

The low-water surface in Bow River is raised approximately 40 ft. by the Bassano Dam. It is a composite structure, the most notable portion being the concrete spillway, 720 ft. in length. This is built with regard to economy of material and of the so-called "Ambursen type," with heavy floor on the bed of the stream, protected by suitable cut-off walls. Upon this are erected buttresses carrying a sloping deck with apron, the whole designed to pass 100,000 cub. ft. of water per second, with extreme height of 13 ft. above the crest. The dam and other works in connection with the scheme are illustrated in Figs. 1 to 6, pages 64 and 65.

The concrete portion of the dam is prolonged westerly within the Horse-shoe Bend by an earthern dyke with maximum height of 45 ft. and length of 7,000 ft., containing about 1,000,000 cub. yards. Extending easterly from the dam is the main canal, five miles in length, partly in a deep cut of 70 ft. bottom width, which, being made in earth of

THE BASSANO DAM AND IRRIGATION WORKS.

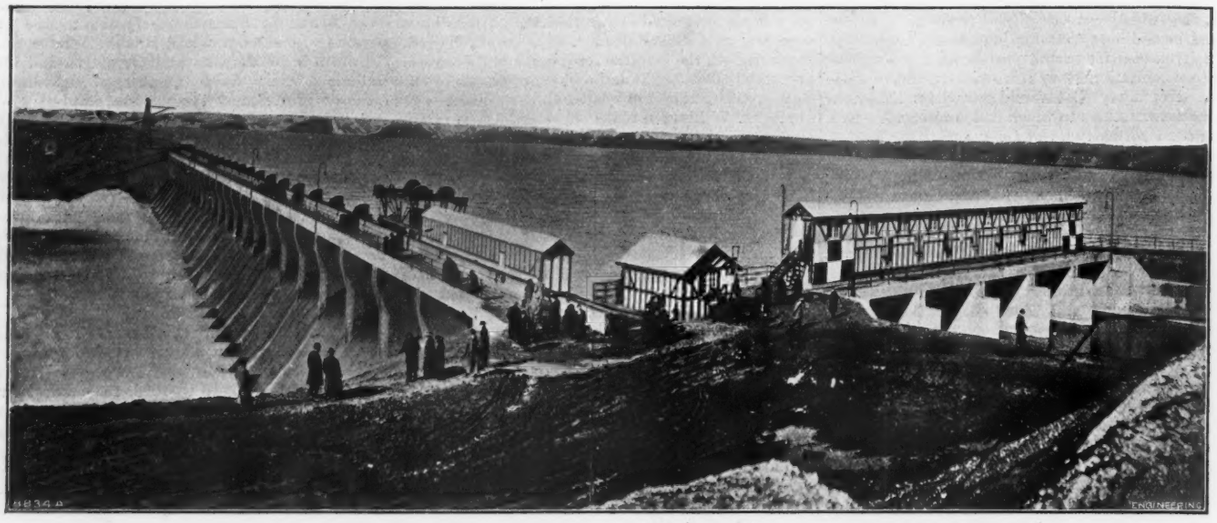


FIG. 1. GENERAL VIEW OF DAM AND HEAD OF MAIN CANAL.

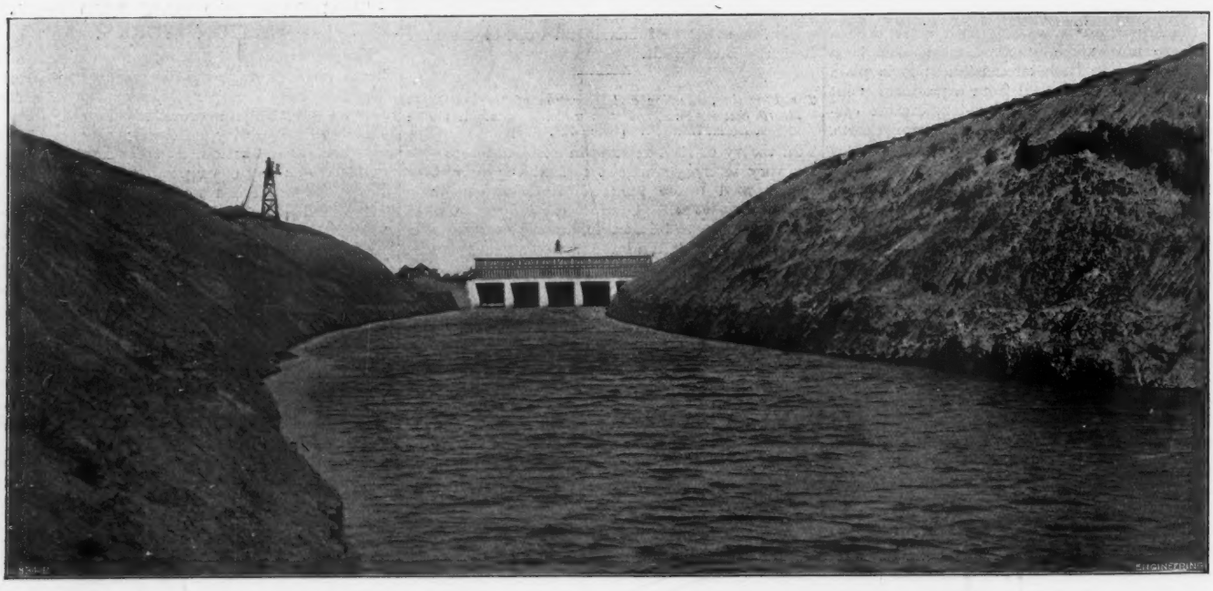


FIG. 2. VIEW OF MAIN CANAL LOOKING TOWARDS HEAD GATES.

somewhat treacherous character, has given considerable trouble. In this respect it is comparable with a number of similar deep earth cuts which have been made and successfully maintained under similar conditions on canals in Montana and other areas. Beyond the eastern end of this cut, the main canal, with a capacity of 3,800 cub. ft. per second, divides, the smaller portion, with a bed width of 30 ft. and a capacity of 800 cub. ft. per second, turning toward the north, while the larger branch, with a capacity of 2,200 cub. ft. per second, continues east. On the northern branch and its subdivisions are many important structures, such as drops and flumes, but the larger number of these is on the eastern canal and its subdivisions.

The most important of the canal structures is the Brooks aqueduct, 10,000 ft. in length, with capacity of 900 second-feet, crossing a broad low depression. The design of this aqueduct is novel, but has been based on careful study with a view to permanence and economy of material. Practically all of the larger structures in the eastern section have been, or are being, built of concrete, the chief exception being several large wooden flumes. The drops in the canal are of substantial design and are constructed of concrete. The smaller structures for distributing water to the farms or groups of farms, number over a thousand. As the country develops, it will be necessary to make a number of changes in the distribution system, with the result that by the time that the smaller wooden structures need renewal, there will exist such a difference in methods and of transportation possibilities that the wood can then be replaced to advantage with concrete. At the same time the plans can be modified to suit the developments which have taken place. The area for which water is being provided, in general, is undulating and with considerable slopes towards Bow and Red Deer Rivers. There are a number of distinct drainage lines traversing the country, and topography, as compared with that of most of the plains region, is favourable for a relatively rapid run-off of excess water. The main drainage system has been provided in part by nature and in part by artificial means.

The first problem under the prevailing climatic conditions is, to induce the farmer to exercise forethought and to use water at the right time; the second, and even more difficult, is to get him to appreciate the danger of using too much water. He is apt to assume that if a little water is a good thing, a large quantity is better, whereas, the larger quantity may be injurious to his crop and to his neighbour's fields, and ultimately may necessitate large, and otherwise unnecessary expenditure for deepening and extending the drains. In order to prevent the occasion for this large expenditure for drainage arising, arrangements are made on many of the new irrigation systems to deliver water on a measured basis, a certain minimum quantity being obtained at a flat charge assessed on all irrigable lands. For example, 50 cents or 1 dollar is to be paid usually in advance, whether the irrigable land receives water or not, and for this, say, one acre-foot can be had. This minimum is set at the amount which is considered to be necessary for the production of the average crop under ordinary conditions, but it is not enough to result in water-logging the soil and in a consequent

THE BASSANO DAM AND IRRIGATION WORKS.

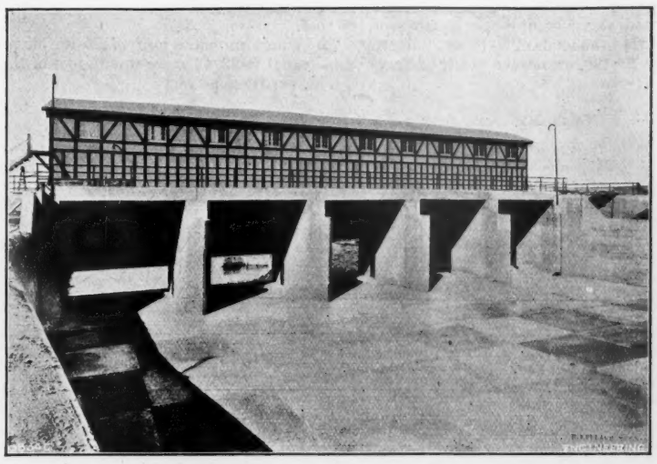


FIG. 3. SLUICE GATES AT HEAD OF CANAL.

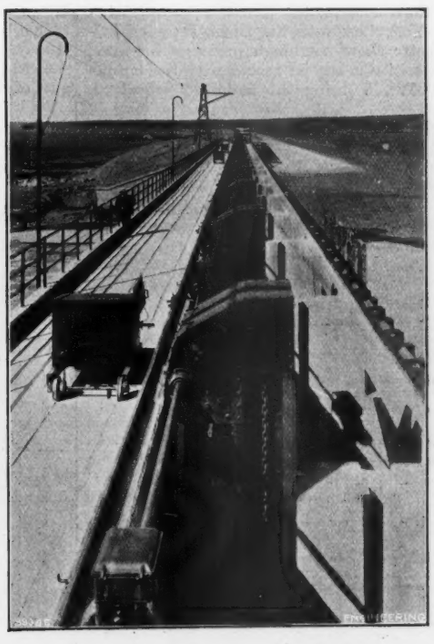


FIG. 5. VIEW ON TOP OF MAIN DAM.

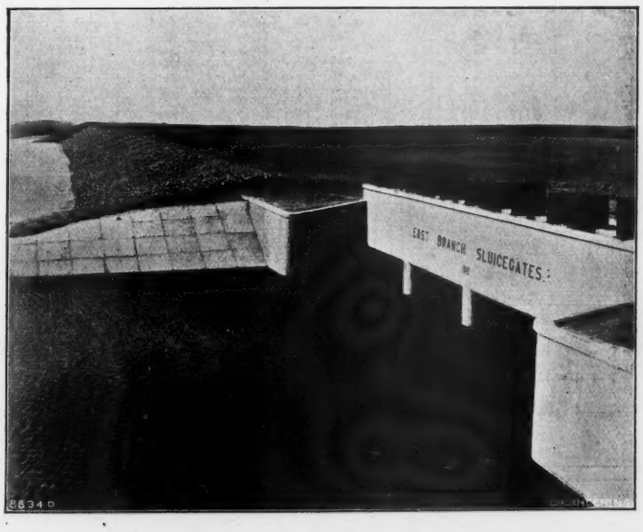


FIG. 4. SLUICE GATES AT HEAD OF EAST BRANCH OF CANAL.

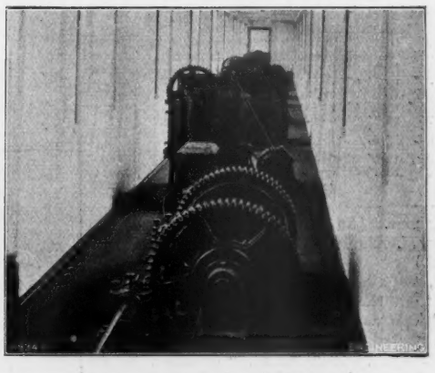


FIG. 6. GATE-OPERATING MECHANISM.

demand for drainage. For all quantities in excess of this minimum an additional charge is made and collected in advance. The result is that the irrigator, being called upon to pay out his money when he demands more water than the minimum, considers very carefully as to whether he really needs the water. As a rule he concludes that he can get along with a smaller amount than he otherwise would deem necessary. Experiments have shown that the largest crop yields are obtained with the minimum amount of water applied, consistent with suitable plant growth, and that while many crops are tolerant of considerable amounts of water, yet the yield is reduced in quantity and quality by excessive application.

The eastern section includes a million acres, out of which there has been selected approximately 440,000 acres, lying in an altitude of from 2,300 ft. to 3,300 ft., which may be irrigated from the system when completed. The tract as a whole is a part of the northern great plains, the surface of which has been modified by glacial action, with resulting heavy underlying deposits of sand and gravel, and particularly of clay, interspersed with large and small boulders. The resulting top soil on the glacial deposits is frequently loamy, usually very rich, and in places slightly sandy. Everywhere it is of suitable depth and quality for excellent crop production. The native vegetation, largely of various grasses, grows luxuriously whenever there is an adequate supply of moisture.

WIND STRESSES IN STEEL MILL BUILDINGS.

By ROBINS FLEMING.

A MATTER of importance to the structural engineer in designing mill buildings is that of wind loads and wind stresses. If his design is competitive, and mill buildings are largely built after competitive designs in which the cost is the governing feature, he knows that if he adheres strictly to the loadings and methods of calculation given in many textbooks his work is liable to be useless as far as securing a contract is concerned.

No standard practice is followed in the design of bracing or in proportioning columns for bending with the result that the engineer is often confronted with a real difficulty as to the method of procedure he should follow. With some slight repetition of an article, "Wind stresses in Steel Mill Buildings" (*Engineering News*, February, 1915, page 210), an effort is made to present a sane and workable method of treating the wind forces in ordinary mill buildings. It may be said at the outset that what is written is for the man at the hoe, the engineer who is actually engaged in the designing and detailing of steel mill buildings.

Wind Pressure.—In the design of mill buildings, not located in regions of extremely high winds, the writer assumes a maximum wind pressure of 15 lbs. per square foot on the sides and the normal component of 20 lbs. as determined by Duchemin's formula on the roof. The reason for using a higher pressure on the roof is partly because the maximum wind may be deflected downward striking the roof with greater force than the normal component of 15 lbs. and also because the roofs of buildings are usually more exposed to high winds than the sides.

According to the well-established formula, $P = 0{\cdot}004V^2$, a pressure of 15 lbs. per square foot is the resultant of a wind blowing horizontally on a vertical surface with a velocity of 61·2 miles per hour. The velocities indicated by a Robinson anemometer according to the correction formula of the U.S. Weather Bureau are greater than the actual velocities. For an indicated velocity of 20 miles an hour the actual velocity is 17·8 miles, for 60 miles it is 48·0 miles, and for 80 miles it is 62·2 miles (it is the indicated velocities that are published and used by writers generally). On the other hand, the published maximum velocities are those

maintained for periods of 5 minutes duration. As winds are more or less gusty, for shorter periods, say for a minute, these velocities are often exceeded. Observations made at the Weather Bureau station in New York City with the Dines Pressure Tube Anemometer show maximum pressures for maximum velocities nearly in accord with the formula $P = 0{\cdot}003V^2$, V being the indicated velocity in miles per hour. (An obligation is here acknowledged to James H. Kimball of the Station for courtesies extended.)

TABLE I.—*Pressure on Inclined Surfaces—Duchemin's Formula.*

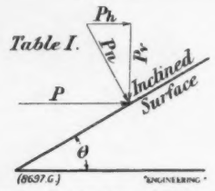


Figure Explanatory of Table.

P = Intensity of pressure on a plane normal to the direction of wind.
P_n = Intensity of normal pressure on a plane inclined at angle θ to the horizontal.
P_v = Vertical component of normal pressure.
P_h = Horizontal component of normal pressure.

$$P_n = P\,\frac{2\sin\theta}{1+\sin^2\theta}$$

$$P_v = P_n\cos\theta = P\,\frac{2\sin\theta\cos\theta}{1+\sin^2\theta}$$

$$P_h = P_n\sin\theta = P\,\frac{2\sin^2\theta}{1+\sin^2\theta}$$

Duchemin's Constants for P_n, P_v and P_h.

Angle θ.	Slope.	P_n.	P_v.	P_h.	Sec. θ.
4° 46′	1″ to 1′ 0″	0·165 P	0·164 P	0·0131 P	1·003
5° 0′	1 1/16″ to 1′ 0″	0·173 P	0·172 P	0·015 P	1·004
9° 28′	2″ to 1′ 0″	0·320 P	0·316 P	0·052 P	1·014
10° 0′	2 1/8″ to 1′ 0″	0·337 P	0·332 P	0·058 P	1·015
14° 2′	3″ to 1′ 0″	0·468 P	0·445 P	0·111 P	1·031
15° 0′	3 3/16″ to 1′ 0″	0·485 P	0·468 P	0·125 P	1·035
18° 26′	4″ to 1′ 0″	0·575 P	0·546 P	0·182 P	1·054
20° 0′	4 1/4″ to 1′ 0″	0·612 P	0·575 P	0·209 P	1·064
22° 37′	5″ to 1′ 0″	0·670 P	0·618 P	0·257 P	1·083
25° 0′	5 5/16″ to 1′ 0″	0·717 P	0·650 P	0·303 P	1·103
26° 34′	6″ to 1′ 0″	0·745 P	0·665 P	0·333 P	1·118
30° 0″	6 15/16″ to 1′ 0″	0·800 P	0·692 P	0·400 P	1·151
30° 15′	7″ to 1′ 0″	0·803 P	0·694 P	0·404 P	1·158
33° 41′	8″ to 1′ 0″	0·848 P	0·707 P	0·470 P	1·202
35° 0′	8 1/2″ to 1′ 0″	0·863 P	0·709 P	0·496 P	1·221
40° 0′	10 1/16″ to 1′ 0″	0·910 P	0·696 P	0·584 P	1·304
45° 0′	12″ to 1′ 0″	0·943 P	0·667 P	0·667 P	1·414
90° 0′		1·000 P	0	1·000 P	∞

Again, the average pressures on large areas are smaller than the pressures on small areas. The Forth Bridge records for the years 1884 to 1890, so often quoted, show that the wind pressure on a pressure board 15 × 20 ft. never exceeded 80 per cent. that on a circular plate of 1½ sq. ft. area, and generally were 50 to 70 per cent.

An indicated velocity of 55 to 63 miles per hour is what Admiral Beaufort in his "Scale," universally used by seamen for more than a hundred years, terms a "whole gale," and of which he writes, "Seldom experienced inland; trees uprooted; considerable structural damage occurs."

***The Duchemin Formula.*—When a horizontal current of air strikes an inclined surface it is deviated from its course. Owing to the fluidity of the air, the friction against the surface is slight and the normal pressure can be determined only by experiment. The Duchemin formula for the intensity of normal pressure, P_n, on a plane inclined at an angle θ to the horizontal is**

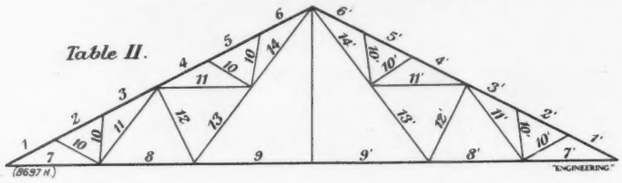
$$P_n = P\,\frac{2\sin\theta}{1+\sin^2\theta}$$

in which P is the intensity of pressure on a plane normal to the direction of the wind. The formula has been amply verified and has come into general use.

Table I above is an enlargement of one found in Arrol's "Bridge and Structural Engineers' Handbook." It is given for reference.

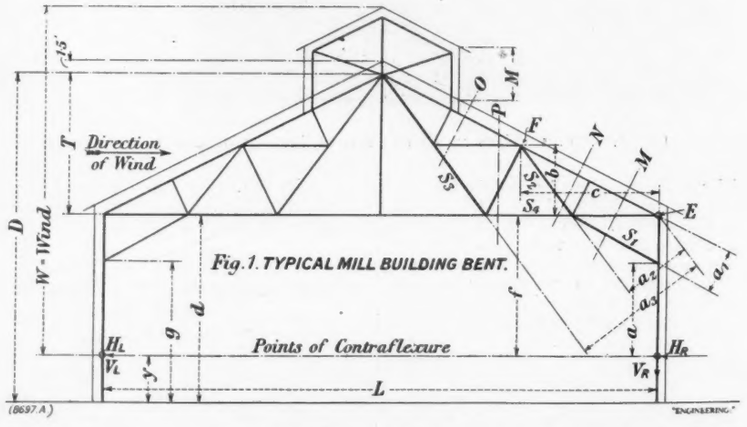
***Wall Bearing Roof Trusses.*—For roof trusses supported on walls a separate stress diagram for wind loading need not be drawn for one truss in a hundred. A load of 30 lb. per square foot over the entire roof surface and acting vertically is ample for providing resistance to any combination of wind and snow loading except in regions where wind or snow is excessive. In regions of no snow 20 lb. may be used. In localities subject to exceptionally high winds or unusual depths of snow, these loads should be increased, say, 5 or 10 lb. per square foot. It may be noted that the loads of 30 lb. or 20 lb. are sufficient to allow for the impact due to any ordinary gust of wind.**

TABLE II.—*Dead, Snow and Wind Stresses in Typical Truss.*



Member.	Stress Unit Panel Load	Wind Load on Left Half.		Full Snow Load on Right Half.		Combinations.			
	A]	Actual Stress B]	B ÷ A C]	Actual Stress D]	D ÷ A E]	F + C + E J]	J ÷ 1·25 K]	F + C + H L]	L ÷ 1·25 M]
1	12·30	109	8·9	75	6·1	25·0	20·0	30·1	24·1
1′	12·30	56	4·6	200	16·3	30·9	24·7	25·8	20·6
2	11·25	100	8·9	75	6·7	25·6	20·5	30·1	24·1
2′	11·25	56	5·0	177	15·7	30·7	24·6	26·2	20·9
3	11·40	109	9·6	75	6·6	26·2	21·0	30·8	24·7
3′	11·40	56	4·9	180	15·8	30·7	24·6	26·1	20·9
4	10·96	109	10·0	75	6·8	26·8	21·4	31·2	25·0
4′	10·96	56	5·1	170	15·5	30·6	24·5	26·3	21·0
5	9·91	100	10·1	75	7·6	27·7	22·2	31·3	25·0
5′	9·91	56	5·7	147	14·8	30·5	24·4	26·9	23·9
6	10·06	109	10·8	75	7·5	28·3	22·6	32·0	25·6
6′	10·06	56	5·6	150	14·9	30·5	24·4	26·8	21·4
7	11·00	134	12·2	67	6·1	28·3	22·6	33·4	26·7
7′	11·00	51	4·6	178	16·2	30·8	24·6	25·8	20·7
8	9·00	102	11·3	67	7·3	28·6	22·9	32·5	26·0
8′	9·00	51	5·7	134	14·9	30·6	24·5	26·9	21·5
9	6·00	51	8·5	67	11·1	29·6	23·7	29·7	23·8
9′	6·00	51	8·5	67	11·1	29·6	23·7	29·7	23·8
10	1·08	18	16·5	0	0·0	26·5	21·2	37·7	30·2
10′	1·08	0	0·0	24	22·4	32·4	25·9	0·0	0·0
11	2·00	33	16·5	0	0·0	26·5	21·2	37·7	30·2
11′	2·00	0	0·0	44	22·4	32·4	25·9	0·0	0·0
12	2·68	44	16·5	0	0·0	26·5	21·2	37·7	30·2
12′	2·68	0	0·0	60	22·4	32·4	25·9	0·0	0·0
13	3·00	50	16·5	0	0·0	26·5	21·2	37·7	30·2
13′	3·00	0	0·0	67	22·4	32·4	25·9	0·0	0·0
14	5·00	83	16·5	0	0·0	26·5	21·2	37·7	32·2
14′	5·00	0	0·0	112	22·4	32·4	25·9	0·0	0·0

C, E, J, K, L, M are equivalent uniform loads in lbs. per square foot of roof surface.
F = Dead load at 10 lb. per square foot roof surface.
G = Full snow load at 22·4 lb.per square foot roof surface.
H = Part snow load at 11·2 lb. per square foot roof surface.
F + G = 32·4 = I = Maximum load.



To wind and snow loads should be added the weight of roof trusses, purlins, bracing and covering. Sheet metal roofs weigh about 10 lb. per square foot of surface, thus making the minimum loadings for which roof trusses should be designed 40 lb. and 30 lb. per square foot distributed uniformly over the entire surface of the roof and acting vertically. In the stress of competition, especially in work for the export field, the foregoing loads are sometimes assumed per square foot of projected area, instead of over the actual roof surface.

By the method of equivalent uniform loading a single stress diagram will answer for any probable combination of dead, snow and wind loads. The engineer should once for all verify for himself the correctness of this statement. He can do so by assuming a unit space, a unit bay, an ordinary type of truss and make separate stress diagrams for:—

(*a*) A uniform dead load of 10 lb. on entire surface of roof.

(*b*) A uniform snow load of 25 lb. on projected area (equal to 22·4 lb. per square foot of surface on a 6-in. per ft. slope roof).

(*c*) The same snow load on one side of the roof only.

A wind load equivalent to 20 lb. per square foot for wind blowing horizontally on a vertical surface, reduced by Duchemin's formula to the normal pressure on roof surface, for cases (*d*), (*e*), (*f*), (*g*) and (*h*) as follows:—

(*d*) Both ends of truss considered fixed, wind on either side.

(*e*) One end of truss considered fixed, the other end on rollers or free to move. Rollers on leeward side.

(*f*) Same as (*e*), except rollers on windward side.

(*g*) One end of truss fixed, the other free to slide on a steel plate. In this case the reaction at the

partially free end is inclined at an angle of about 18 deg. from the vertical away from the end, this being the angle of friction of steel upon steel. Steel plate on leeward side.

(*h*) Same as (*g*) except plate on windward side.

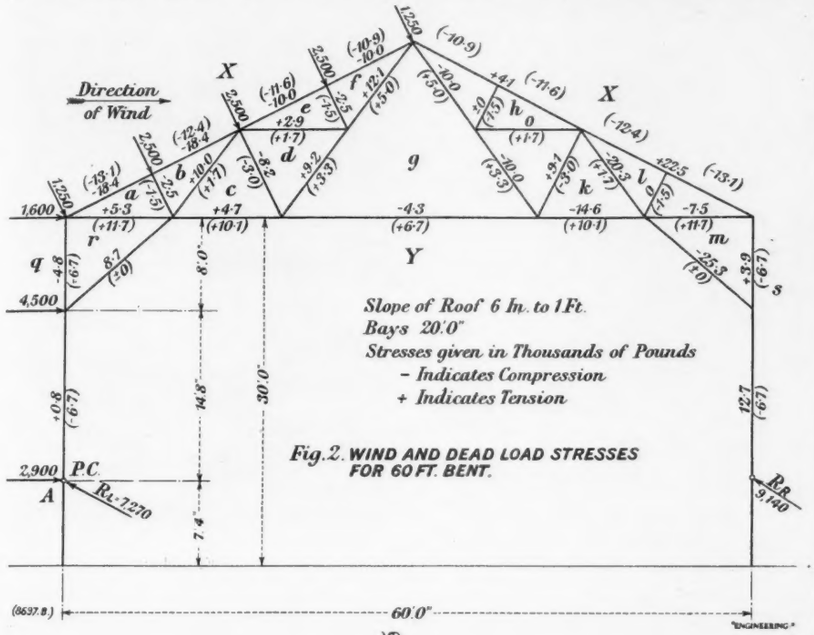


Fig. 2. WIND AND DEAD LOAD STRESSES FOR 60 FT. BENT.

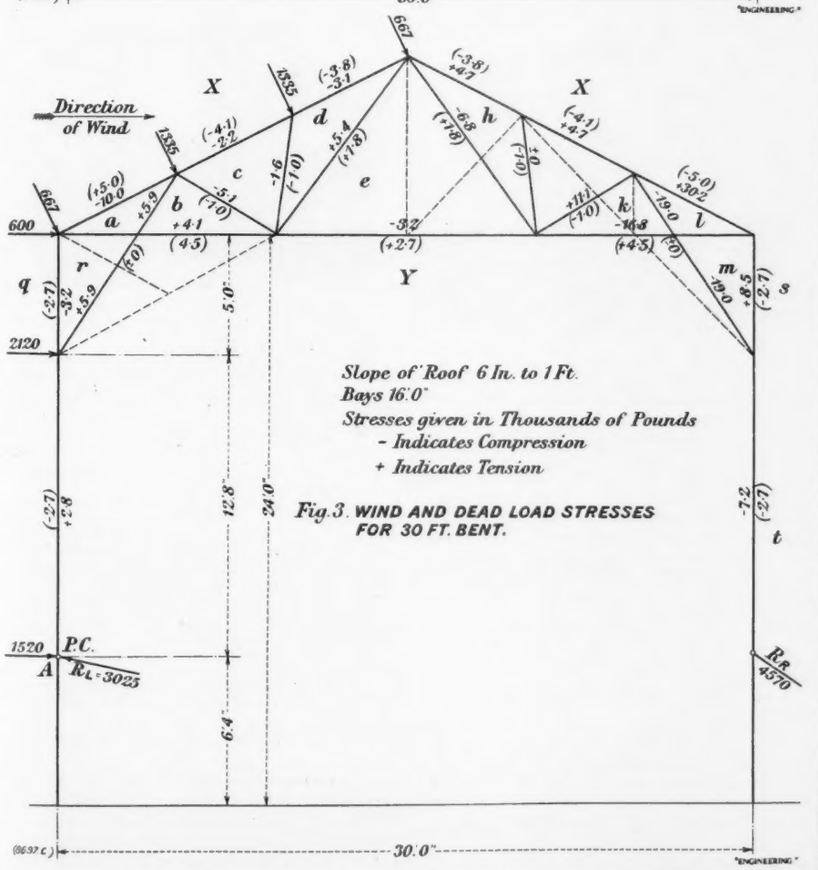


Fig. 3. WIND AND DEAD LOAD STRESSES FOR 30 FT. BENT.

(*i*) A uniform load of 40 lb. per square foot on entire surface of roof. Stresses are four times those of (*a*).

(*j*), (*k*), (*l*) From (*i*) stresses due to 30 lb. per square foot of roof surface, 40 lb. per square foot of projected area and 30 lb. per square foot of projected area can be found by proportion.

All probable combinations of dead, snow and wind loads should be considered. While the maximum snow and the maximum wind will not occur on the same half of the truss at the same time, a light snow covered with a crust or a coat of sleet may be over the entire roof surface during a heavy wind. When the slope of roof is less than 30 deg. a weight of half the snow load should be assumed for such loading.

It is seldom necessary to use rollers for spans under 100 ft., but it is possible that wind shear may all or nearly all, come upon one wall due to unequal bedding of anchor bolts or to temperature movements. The conditions then are the same as one end on rollers: (*e*) and (*f*) preceding, or perhaps more nearly as (*g*) and (*h*).

It may seem needless for the engineer to verify the assumption of equivalent uniform load to the extent suggested, but it may be stated that each particular case mentioned is found in some textbook as worthy of consideration.

A colleague of the writer, Mr. George E. Howe, has made an interesting study of the stresses due to the different loadings that may come upon ordinary roof trusses. For a 6-in. per ft. slope roof of unit panel lengths he assumes a dead load of 10 lb. per square foot of roof surface, a snow load of 25 lb. per square foot ground area (equivalent to 22·4 lb. roof surface), and a wind load of 20 lb., reduced by Duchemin's formula. The equivalent uniform loading is found for each case considered (see Table II). The combinations of dead, wind and one-half snow are divided by 1·25, because codes and specifications allow 25 per cent. or more increase in unit stresses for loads including the wind. In no member is the load greater than that of the combined dead and snow loads.

Again, if the vertical components of the reactions from the wind load remain constant the only stresses affected by a change in the horizontal component are the stresses in the bottom chord, provided the bottom chord is horizontal.

(The writer wishes to take this opportunity of acknowledging his obligation to Mr. Howe, for the assistance he has rendered in the preparation of this article.)

Mill Building Bents with Kneebraces.—The dead and snow load stresses in the truss of a transverse mill bent, such as shown in Figs. 1, 2 and 3, are the same as if the truss were supported on brick walls. The columns carry the vertical reactions and the kneebraces are assumed to take no stress. The stresses due to wind loading are statically indeterminate. Owing to the impracticability in ordinary design of calculating stresses in statically indeterminate structures by exact methods, it is necessary to make certain assumptions and use approximate methods. If the points of contraflexure are located and the horizontal reactions are known a wind stress diagram can be drawn.

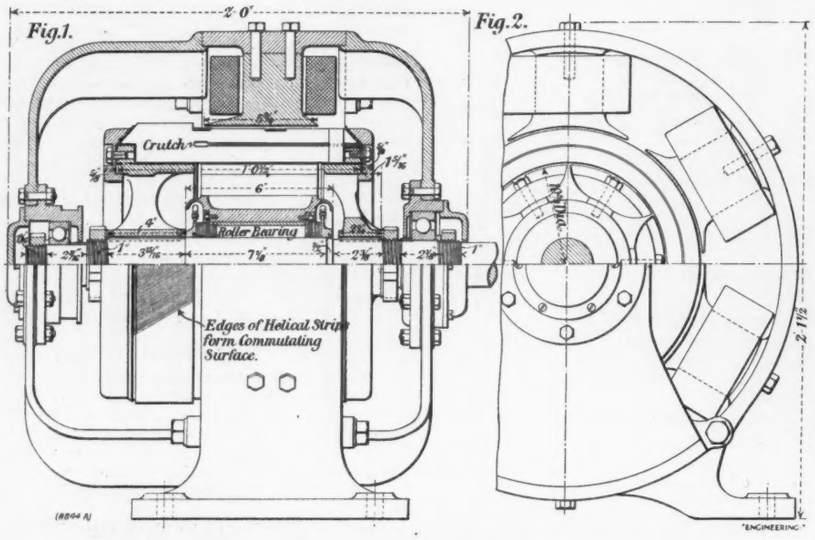
For a bent as in Fig. 1, with bottom ends of columns fixed and top ends simply supported, the points of contraflexure are located by the equation $y = g/2\left(\frac{g+2d}{2g+d}\right)$. For $g = 2/3d$, $y = 4/7g$; for $g = 3/4d$, $y = 11/20g$. But the bottom ends are never perfectly fixed, which tends to lower the points of contraflexure. The writer some years ago saw a transmission tower tested to destruction. The base of each leg was firmly bolted to two 24-in. I-beams. The results of the test plainly showed that even with this rigid fastening the ends were *not* fixed (see an article: "Fixed-End Columns in Practice," by Professor C. T. Morris, *Engineering News*, November 2, 1911, page 530). At the same time the top ends are not simply supported or free to turn, but are riveted to the truss, which tends to raise the points of contraflexure. As a compromise some engineers assume the points of contraflexure to be midway between the base and the kneebrace, or $y = 1/2g$ in Fig. 1. The writer believes that with set anchor bolts $y = 1/3g$ to be more nearly correct, and uses this assumption in his work, due consideration being given to the design of base and anchorage. Here, again, caution is necessary. Anchor bolts may be poorly set, swedge bolts may be used or the footings may be so light that they do little toward fixing the columns. Such cases, according to textbooks, come under columns free to turn at base and top—a safe but rather severe classification.

The horizontal reactions are assumed each equal to one-half the horizontal components of the wind loads above the point of contraflexure. It is only the wind loads above the point of contraflexure that produce stresses in the bent; the wind load below this point is carried by shear directly to the base of the column. Professor Ellis, in his "Theory of Framed Structures," 1922, one of the latest books on the subject, assumes from an analysis made in accordance with the elastic theory of structures that the horizontal reactions at the points of contraflexure

THE BROOKS SAYERS ELECTRIC GENERATORS AND MOTORS.

CONSTRUCTED BY THE SPEEDWELL PRESS COMPANY LIMITED, ENGINEERS, LETCHWORTH.

(For Description, see opposite Page.)



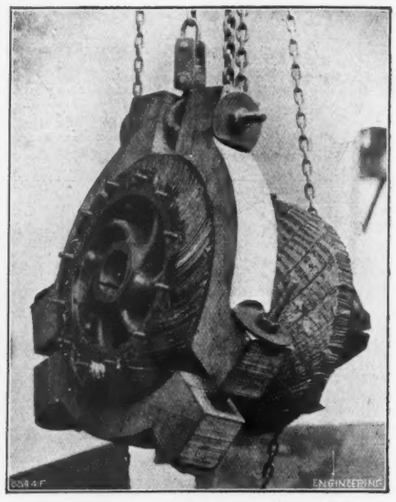


FIG. 3.

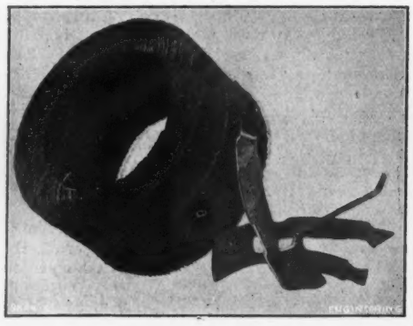


FIG. 4.

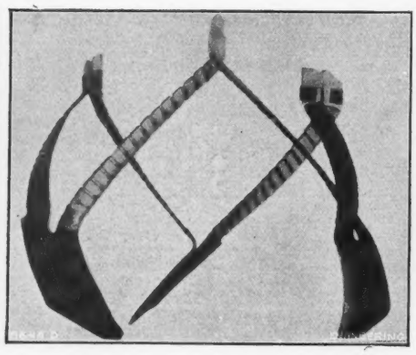


FIG. 5.

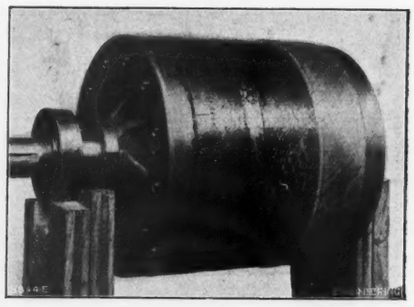


FIG. 6.

of the windward and leeward columns are five-eighths and three-eighths of the sum of the horizontal components of the wind loads above. However, as he states, his analyses were too limited in range to draw general conclusions. So there is at present no sufficient reason for departing from the usual assumption of equal horizontal reactions.

A wind stress diagram can now be drawn. (See Ketchum, "Steel Mill Buildings," fourth edition, 1921, p. 567 *et seq.*) Fig. 2 shows the stresses in a bent of dimensions noted for a wind pressure of 20 lb. per square foot on sides and 20 lb. reduced for roof. The figures in parentheses are due to an assumed uniform dead load of 10 lb. per square foot of roof surface, this being the minimum weight of a roof with sheet metal covering. The case of a wind load of 20 lb. with but a dead load of 10 lb. to resist it is more severe than will come upon most buildings.

On the windward half of the truss it is seen that the stresses from wind are of the same sign as those from dead load. If the truss is designed for a minimum total load of 30 lb. or 40 lb., as previously mentioned, no member, except *bc*, need be increased for additional wind stress. A tensile stress occurs in the kneebrace.

On the leeward half of the truss a reversal of stress occurs in several members. As the members *kh* and the top chord are designed for compressive stresses of at least three times that from the 10 lb. dead load no special provision need be made for the tensile stresses in these particular members. Consideration, however, should be given to the compressive stresses in the members *k*Y, *kl*, *gh* and the kneebraces *m*Y.

For trusses kneebraced to columns, Ellis, in his book previously quoted, writes, "the wind load may without serious error be considered vertical and included with the dead and snow loads, if special attention is given to the columns, kneebraces and the web members which are connected to the kneebraces and nearest in line with them." In cutting sections M, N and O and taking moments about E (Fig. 1) the compressive stresses from wind are obtained by the equations

$$S_1 a_1 = H_R f;\ S_2 a_2 = H_R f;\ S_3 a_3 = H_R f;$$

from which

$$S_1 = H_R f/a_1;\ S_2 = H_R f/a_2;\ S_3 = H_R f/a_3.$$

To find the compressive stress S_4 it is necessary to find the vertical reaction V_R. This is equal to the sum of the vertical reactions due to the vertical and horizontal components of the wind loads. (See P*v* and P*h* of Table I.) Cutting section P and taking moments about F (Fig. 1)

$$S_4 b = H_R (f + b) - V_R c$$

whence

$$S_4 = \frac{H_R (f + b) - V_R c}{b}$$

The reactions and principal wind stresses are best found algebraically. The graphical method need be used only in cases where it is desirable to investigate all the members of the truss.

The horizontal pressure on an inclined surface is not the intensity of pressure P multiplied by the vertical projection of the surface, as is sometimes assumed, but is the horizontal component P*h* of Table I, multiplied by the area of the inclined surface—that is, P*h* × horizontal area × sec. θ. It may also be expressed as P*h* × vertical projection of area × cosec θ.

The maximum bending moment in the columns is at the foot of the leeward kneebrace, and is equal to $H_R a$. The maximum moment at a base is that of the leeward column, and is equal to $H_R y$. For columns considered free to turn at both ends, y equals zero and there is no moment. Of course, with wind blowing from right to left, the windward sides of Figs. 1 and 2 become the leeward sides.

A number of variables enter in deciding whether or not a separate wind stress diagram need be drawn for a bent. In general none is needed for bents with or without monitors if the height to bottom chord does not exceed one-half the span and consideration is given to S_1, S_2, S_3, and S_4 as determined by moments. The ratio of one-half is conservative; six-tenths in most cases could safely be followed. The bents in the majority of buildings are of such spans and heights that the only necessary departures from proportioning for equivalent uniform loading are for the compressive stresses S_1 and S_2 and the columns for bending.

Fig. 3 shows wind stresses in a bent of the dimensions noted. Wind load is assumed at 15 lb. on side and 20 lb. reduced on roof surface. Figures in parentheses are due to a uniform dead load of 10 lb. per

BROOKS SAYERS ELECTRIC GENERATORS AND MOTORS.

CONSTRUCTED BY THE SPEEDWELL PRESS COMPANY, LIMITED, ENGINEERS, LETCHWORTH.

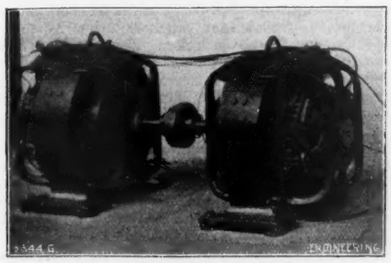


FIG. 7.

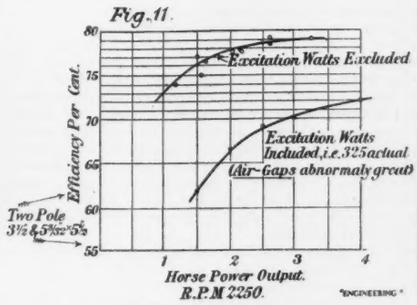
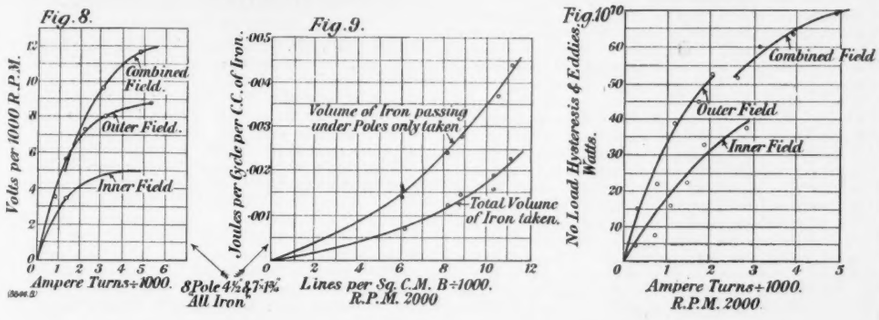


Fig. 11.
Excitation Watts Excluded
Excitation Watts Included, i.e. 325 actual (Air-Gaps abnormaly great)
Efficiency Per Cent.
Two Pole 3½ & 5½ x 5½
Horse Power Output. R.P.M 2250.



sq. ft. of roof surface. For this bent a separate wind stress diagram is needed. Such would not be the case with a kneebrace, as shown in dotted lines on the left half of the truss. All truss members could then be proportioned from the equivalent uniform loading except the members *eh* and the kneebrace. The compressive stresses in these members can be obtained by taking moments as in Fig. 1. If such a kneebrace interferes with headroom it and the web members of the truss may be as shown in dotted lines on the right half of the figure. This arrangement often possesses a decided advantage for bents of short span.

(To be continued.)

THE BROOKS SAYERS DYNAMO ELECTRIC MACHINERY.

THE ordinary continuous current machine, whether dynamo or motor, long ago arrived at such a stage of mechanical and electrical efficiency that there seemed little chance of any great modification of the design. Nevertheless, as has happened in similar cases, it has been found possible to devise a variation from established practice in electrical design which has many interesting features, as will be evident from the figures on the opposite page and above. The machine shown, which we will call a motor for brevity although it will function equally well as a generator of current, is the invention of Mr. W. Brooks Sayers, of 6A, Tudor-street, London, E.C. 4. It is claimed to be much lighter and more robust than a motor of the ordinary type, to open the way for higher efficiency by more economical and intense employment of active iron and copper, and to lend itself to very cheap production when made on a large scale. The special features of the new motor lie almost entirely in the armature, for the field magnet system generally follows ordinary practice. The armature is composed of two mechanically independent parts, an iron core and a system of conductors. The core is stationary and is mounted on ball- or roller-bearings, so that the shaft can run freely within it. Reference to Figs. 1 and 2 will make the construction clear. The magnetic flux passes from pole to pole through the stationary armature, traversing twice in its path the conductor system. This consists of a cylindrical construction, illustrated in Fig. 4, carried on a spider at each end, the spiders being keyed to the shaft. The core is held stationary by the magnetic flux and the cylindrical conductor system cuts the flux as it revolves.

The conductors are copper laminations stamped out in a peculiar form, each lamination having two legs which unite and merge into the broad end-piece at the point marked "crutch" in Fig. 1. The shape of the stamping is not nearly so simple as a hasty glance at the drawing might suggest, because all parts lie in an involute curve, when the rotor is looked at from the end, and the laminations also traverse the rotor in a spiral form. An inspection of Figs. 3 and 4 will show how such laminations can be built up to form a cylindrical body. The edges of the broad ends of the laminations form the commutator, on which the usual carbon brushes ride, a separate commutator being thus dispensed with. The two legs of each lamination are bent in opposite directions, so that one takes a spiral path on the outer side of the cylinder and the other takes an opposite spiral path on the inner side. Placed alternately between the copper laminations are similar ones of iron which have the effect of enormously reducing the magnetic reluctance of the path of the flux. These iron laminations act as conductors also, and are continued right along to form the commutator exactly as the copper ones. The laminations are grouped into numbers sufficient to give the required conductor cross section, and each group is insulated from its neighbours by tape wound along it. The groups being put together, form a complete cylinder, the inner ends of one group coming directly beneath the outer ends of another group, so that the respective ends have only to be connected by clips sweated on, to form a continuous winding. In Fig. 5 are shown three consecutive groups connected in series in the manner described. The broad lower portions form the commutator sections, these, of course, being solid with the conductors so that there is no soldering required at the commutator end. Fig. 3 shows a rotor clipped on to its spider, and Fig. 6 shows a completed rotor, the commutator end being on the right-hand side.

A pair of Brooks-Sayers machines coupled together for a Hopkinson test in the works of the Speedwell Press Company, Limited, at Letchworth, where the machines were made, are illustrated in Fig. 7. The machines are similar to those shown in Figs. 1 and 2 and are rated at 220 volts and 126 amperes or 28 kw. at 900 revolutions per minute. Each machine weighs 784 lb. or about 35·5 lb. per kilowatt. The armatures are 14 in. diameter, with a peripheral speed of 3,300 ft. per minute. Figs. 8, 9 and 10 refer to the performances of the cylinder shown in Fig. 4, which is for an eight-pole machine rated at 1 kw. at 2,000 revolutions per minute. Fig. 8 shows the voltage produced in the cylinder with different conditions of excitation, namely with the inner field only excited, the outer field only excited, or with both fields excited. Fig. 10 shows the hysteresis and eddy current losses under the same respective conditions, while Fig. 9 shows the losses per cycle per centimetre of iron with the combined fields. In the upper curve the iron passing under the poles is alone taken into account, but on the lower curve the total iron, including that in the commutator extension is taken. The curves in Fig. 11 are self-explanatory, and refer to the performance of an early two-pole machine which has been tested. From the various curves it is possible to draw conclusions as to the capabilities of the type of construction used, which is not only novel, but appears likely to have decided advantages where a very light machine is required.

TALKING MOTION PICTURES.

SINCE the inauguration of the kinematograph industry the problem of talking motion pictures has occupied many inventors. The easiest solution seemed to be to synchronise a phonograph, or gramophone, record with the picture film. But the maintenance of this synchronism is exceedingly difficult. The phonofilms by which Dr. Lee de Forest has quite recently achieved considerable success, secure synchronism between movements and sounds in a novel way and dispense with the use of gramophones. The method was demonstrated by Mr. C. F. Elwell, B.A., in two discourses delivered on January 7 and 8 in connection with the Physical and Optical Societies' Exhibition. We may first outline the method, as described by Mr. Elwell, and then give some details of the special apparatus used which were all made by the Western Electric Company.

Dr. de Forest uses the ordinary standard kinematograph film, 1 in. in width, but he records the sound signals on the film itself between the row of perforations on the left and the picture proper. The picture is taken in an ordinary kinema camera, which contains, in addition, a sensitive glow-discharge lamp, the A.E.O. cell of Case. The light from this lamp, which is described below, shines through a fine slot, 0·0015 in. in width and 0·1 in. in length. The words or musical sounds to be reproduced are picked up by a special microphone, the currents of which are amplified by a triode valve and then recorded photographically upon the edge of the film, through the agency of the glow-discharge lamp mentioned above. The records look exactly like a spectrum displayed vertically and consisting of black lines varying in width, but all of the same length, and lying at right angles to the length of the film. This film, on which sound and motion pictures are in perfect synchronism, is then developed; any number of positive prints can be taken from the negative.

For the reproduction of these photographic sound records the roll of the positive film is placed into an ordinary projector fitted with an attachment containing a 6-volt lamp, a slot of the dimensions stated (0·0015 in. by 0·1 in.), a guide for the film and a Case thalofide light-sensitive cell. The sound spectrum passes in front of the slot, and the light penetrating through the film, varying with the widths of the spectrum lines, sends a fluctuating beam into the thalofide cell, the electric resistance of which varies with the intensity of the incident light. The current fluctuations resulting from the variations in the intensity of the light, are amplified by a four-stage valve amplifier, which magnifies them sufficiently to operate two Western Electric loud speakers.

These are the essential points of the system. The special microphones may be the double-button transmitter type of the Western Electric Company, working with a diaphragm of Duralumin, about 0·002 in. in thickness, stretched between two heavy rings in front of a perforated metal plate so that a damping air film 0·001 in. in thickness is left between the plates. This type of transmitter, an example of which was illustrated and described in our issue of April 25 last on page 560, is recommended only when the speaker is not more than 6 ft. from the microphone, but by decreasing the tension and the damping, *i.e.*, increasing the air space, it can be made available for taking up musical notes at distances of 20 ft. from the microphone. In general, however, the condenser type transmitter of the same company is preferred. This consists of a steel diaphragm, 0·002 in. in thickness, mounted 0·001 in. in front of the condenser backplate. The capacity of this condenser is about 400 micro-microfarads, and the capacity fluctuations in the instrument are of the order of 0·01 per cent. The natural frequency of the diaphragm is varied by cutting annular grooves into the face of the backplate and the mean value of the sensitivity of the transmitter is 0·35 millivolt per dyne.

A distortionless amplifier is a very essential part of the apparatus. The sensitive glow-discharge lamp of Mr. T. W. Case, of the A.E.O. (alkaline-earth-oxide) type, consists of a filament and a plate close to it, mounted in a lamp bulb. The filament, coated with barium or strontium oxide, emits electrons on 150-volt or 200-volt circuits giving rise to a glow-discharge in the helium, with which the bulb is filled at a pressure of 100 mm. of mercury. The light produced

is concentrated in a small space, and with 5 milliamperes passing between the filament and plate, the brilliancy varies rapidly in accordance with the sounds received by the microphone, since the varying current from the latter (highly amplified) is passed through the lamp. The light-sensitive thalofide cell, also due to Case, consists of a glass bulb containing a fused-quartz disc upon which an oxidised thallium-sulphur compound has been spread. By an ingenious method, lead is sprayed on this material to ensure freedom from "frying" noises after amplification. Since the cell has a resistance varying between 500 and 5 megohms, enormous magnification is required for operating the loud speakers. The thalofide cell is most sensitive to infra-red radiations. The loud speaker, which Mr. Elwell so far considered the weakest link in the chain of apparatus, is constructed of corrugated parchmentised linen. The pole pieces of the permanent magnet system overlap and house two small circular coils of low impedance and having resistances of 120 ohms or of 250 ohms (in different models); a small bar armature threads the coils axially, moving vertically with a clearance of 1 mm. One end of the armature is joined to the loud-speaker diaphragm centre by a stiff wire; the armature is actuated by the signal currents through the low-impedance coils.

The interesting demonstrations of the phonofilm comprised a telephone monologue, a banjo solo, a dance with accompaniment, a concert by 35 instruments, a violin solo, and a speech by President Coolidge delivered in the garden of the White House. The reproductions were highly appreciated by crowded audiences and, although not perfect, were remarkably good considering the many energy conversions involved, the enormous amplifications needed at different stages, and the diverse imperfections of the various apparatus. Mr. Elwell remarked, in conclusion, that active development work was being carried on in London.

LETTERS TO THE EDITOR.

THE EFFECT OF LOW AND HIGH TEMPERATURES ON MATERIALS.

To the Editor of Engineering.

SIR,—Referring to the report in ENGINEERING of January 2 of the meeting of the Manchester Branch of the Institution of Mechanical Engineers, at which Professor Lea's paper upon the above subject was read, I would like to correct an impression conveyed by the report of my contribution to the discussion—namely, that I have carried out work upon the phenomenon of creep. I was referring to the work of Dickenson, and if the second sentence of the report of my remarks is replaced by "Dickenson had attacked the subject of temperature effect from a different point of view from that of Professor Lea," my intentions would be conveyed.

It is further desirable to extend the fifth sentence to indicate the method of plotting used by Dickenson, so that this sentence would read, "The whole of the data gave straight lines when temperature was plotted against the logarithm of the time to fracture." It would be correct to change the word "stress" to "temperature" in the sixth sentence.

The verbatim report makes it clear that I was difficult to hear from my position, and therefore I am responsible for the misinterpretation.

Yours faithfully,
R. W. BAILEY.

23, Stockport Road, Altrincham.
January 10, 1925.

"THE PHYSICS OF INTERNAL COMBUSTION ENGINES."

To the Editor of Engineering.

SIR,—I saw with much interest in your leader "On the Physics of Internal Combustion Engines," in your issue of November 14 last, a reference to a proposal of mine to calculate the heat radiated when combustible gas mixtures are fired based on the assumption that each molecule formed by combustion radiates a quantum of energy h, ν, where ν is the frequency of *observed* wave lengths and h is Planck's constant. In accordance with the above the radiated heat would be no more than about 18½ per cent. of the total heat of combustion for water and carbon dioxide—and this is not enough to explain the much discussed missing pressure.

I would like now to supplement my calculation of last year by a few remarks with regard to combustion of gas mixtures. The kinetic gas theory as known before Bohr is unable to explain satisfactorily. (1) The deficiency in pressure, after firing, of combustible mixtures. (2) The increase of specific heat of gases with the temperature. (3) The heat radiated when a combustible gas mixture is fired.

By accepting Bohr's constitution of an atom a plausible explanation of the above facts can be made out as follows:— The heat freed by the combining of atoms attracting each other to form molecules, appears in the first instant mainly as rotational energy owing to the generally eccentric meeting of the two trajectories. This will result in a violent rotation of the combining atoms round the common centre of gravity, with the result that the newly-formed molecule will have an excess of rotational energy. Probably, during the phase of strong attraction between the atoms or owing to excessive centrifugal forces during rotation, electrons constituting the atoms are lifted out of their stable orbits and energy is thus absorbed. The violent rotation of the newly-formed molecule together with the falling back of electrons into more stable orbits will emit radiations, and such in a series of waves known as band spectra.

We can imagine in a gas molecule collisions of such strength as to lift electrons out of their stable orbits. This would explain the increase of specific heats with rising temperature, provided that radiation is actually observed on the cooling of the gas to temperatures where the specific heat is nearly constant. Thus, the pressure deficiency, the increase of specific heats and also radiation could be explained. (1) By energy being absorbed in lifting electrons out of their stable orbits. (2) By rotational energy being radiated away in addition to the former. (3) By abnormal rotational energy which would not influence the pressure.

My assumption in last year's calculation that each molecule radiates one quantum is probably incorrect, because the rotational energy of the newly-formed molecules will be different and depending on the direction of movement of the uniting atoms towards each other. In case the atoms move in opposite directions before uniting the rotational energy will be much higher than if they move in the same direction.

The unequal distribution of rotation will be the cause that not every molecule radiates the same amount of energy. Only a certain percentage of newly-formed molecules will have sufficient rotational energy to emit radiation. Thus, the 18 per cent. of radiated energy I calculated as a maximum will have to be reduced, and this will agree with recent experiments which certainly do not give to the radiation such a high percentage.

Even the 18 per cent. of radiant heat is not enough to account for the missing pressure, and the assumption of excessive rotational energy is thus necessary. To the argument that the large number of collisions would instantaneously bring about equipartition it may be answered that according to recent knowledge, rotational energy exists only in quanta $h\nu$ where ν would now be the number of rotations. Thus, in molecules having a high rotational energy the quantum $h\nu$ would be large and collisions strong enough to absorb this quantum would be few, particularly in a mixture of gases like newly-formed carbon dioxide and water vapour diluted in nitrogen.

The above remarks contain probably a part of the truth, but the extent of approximation can only be ascertained by a thorough criticism.

Yours faithfully.
A. MELENCOVICH.

6, Agesilaou Street, Athens.

FLYWHEELS AND TORQUE PULSATIONS.

To the Editor of Engineering.

SIR,—During the discussion on the first Report of the Marine Oil-Engine Trials Committee, as reported in your issue of November 28, 1924, particulars were given of torsion measurements obtained with an electrical torsionmeter arranged to record cyclic variations of torque during one revolution. There seems to be some difficulty in harmonizing the results obtained with those predicted from land tests of the engine, but whether the mean torsion be correct or incorrect, it may be assumed that the form of the curve of cyclic variation represents in a general way the amplitude of change of torsional force.

Commenting on this variation, it was stated to be "rather remarkable that so sudden a change of stress should reach right through past the flywheel." This statement is in accordance with generally expressed opinion that a flywheel, because of its great inertia, will prevent the transmission of torsional pulsations of high periodicity from engine-shaft to propeller-shaft, or, at least, will reduce substantially the amplitude of variation. Is it not more logical to argue that, because of its great inertia, a flywheel is incapable of arresting to any large extent these rapid variations of torsional stress?

If it be assumed that a flywheel does damp out these variations, then all the damping effect must take place in the short length of shafting covered by the flywheel, since it is also assumed that large variations exist on the engine side of the wheel and are diminished on the other side. This does not seem reasonable, especially if the shaft diameter be increased to form a collar to which the flywheel is bolted.

It is proved in the report that pulsations of torsion were very clearly present between the flywheel and the propeller, and that they originate primarily in the engine, and not in the propeller. This confirms results already obtained from an oil-engined ship tried previously to the tests of the M.S. Sycamore, and it does not seem remarkable, but rather inevitable, that these rapid pulsations "should reach right through past the flywheel."

Can any of your readers who deal with flywheel problems explain why it is expected that an ordinary flywheel, constructed of elastic material, should be able to reduce sensibly the amplitude of variation of stress in a shaft driven by a reciprocating engine?

Yours faithfully,
QUERY.

"THE WHITWORTH SCHOLARSHIPS."

To the Editor of Engineering.

SIR,—I think Mr. Millington's letter in your issue of the 2nd instant creates the impression that a scholar has perforce to spend his three years' tenure in academic pursuits. This was by no means the case. Out of my three years' tenure, two years and three months were spent in works, and I know of other cases somewhat similar. Indeed, contrary to Mr. Millington's view I have always regarded the Whitworth scholarships as of unique value to young engineers in that they enabled practical experience to be acquired of a kind and under conditions which would be extremely difficult to obtain otherwise.

If the Board of Education is now as broadminded in its interpretation of the objects of the scholarships as it was under the old scheme, the character and result of tenure now, as then, will depend largely upon the bent of the scholar.

Yours faithfully,
R. W. BAILEY.

23, Stockport Road, Altrincham.
January 10, 1925.

"THE REMUNERATION OF TECHNICAL MEN."

To the Editor of Engineering.

SIR,—Referring to the low remuneration offered to technically trained men by the Royal Aircraft Establishment, Farnborough, and the comparison, by "Engineer Manager," with marine and other branches of engineering, I should like to point out that aviation is scarcely out of its infancy, and consequently there cannot be many men, trained technically in aeronautics, who could carry on the work commenced by the pioneers of flying and those who gained their experience under pressure of necessity during the years of the Great War. Anybody not so trained must of necessity take some time to pick up the threads, which time would be lost to the interests of aviation.

The vacancies at the R.A.E. appear at present to be filled from men who hold engineering degrees, but are not trained in aeronautics; in fact, many, if not most, of them have never seen an aeroplane close up nor even drawings of aircraft, until they arrive at the establishment. It is these men who have the supervision of aircraft design to ensure the general safety of the flying public and R.A.F. personnel. Perhaps this accounts for the comparative slowness with which the Air Ministry sanctions new designs.

There are now a few technical colleges and training centres where training in aeronautics can be obtained, but so far no degrees in aeronautics are available. This latter fact seems to be the drawback when aeronautical students with training and certificates apply for technical posts, for degrees in engineering (mechanical and similar branches) although not signifying any knowledge of aeronautics, seem to carry most weight with the powers that be.

This leads me to suggest that young blood of a purely aeronautical nature is scarce, but yet is crowded out of such places as the Royal Aircraft Establishment at Farnborough by the overflow from other branches of engineering. If this continues for very long it will tend to bring the progress of aviation to a standstill in this country. This method on behalf of such establishments as the R.A.E. might lead to economy in the weekly or monthly salary bill; it also leads to loss in the time factor of economy and progress, and the final result will be loss of economy when work is balanced against *l. s. d.*

Yours faithfully,
"AERONAUTICAL DIPLOMA."

Palmer's Green, N., January 7, 1925.

WATER-LINED FURNACE WALLS FOR POWER STATION BOILERS.

THE introduction of the steam turbine led to an extraordinary reduction in the size of the engine room required for a stated output. Boilermakers were slow to make any corresponding advance, and in most power stations the contrast between the large battery of boilers and the compact turbine which took all the steam these were able to supply was most striking. It had, in fact, been evident for some time past that drastic changes in boiler practice were long overdue and that outputs must be substantially increased. In naval practice high rates of evaporation had, it is true, been at times attained, but only at some considerable sacrifice of efficiency. Whilst a low evaporative efficiency is tolerable for temporary ends, present prices of fuel render high boiler efficiencies imperative in ordinary daily practice and the problem has been, therefore, to attain a high output of steam without sacrifice of fuel economy.

The very large power stations which have been erected in America have emphasised the need for an increase in boiler output, and rates of combustion have for some time past ruled much higher there than are customary here, whilst, at the same time, very high evaporative efficiencies have been secured. This has, in part, been due to the fact that at these very large stations it is practicable to employ specialists whose sole duty it is to study fuel economy and to check incipient wastes before the loss becomes serious, but in the main the excellent figures recorded are attributable to improvements in design.

It has been found that large combustion chambers are an important factor in the attainment of high rates of evaporation. With such large combustion chambers more coal can be burnt per square foot and yet the combustion can be, and is, completed before the gases reach the boiler tubes. Hence these large furnaces have been widely adopted in America for modern power plants having mechanical stokers and still larger ones are employed where the fuel used is powdered coal.

Furnaces of this kind, however, expose a good deal of brickwork to extremely high temperatures, and it has therefore been found necessary to protect this brickwork in some way. With powdered fuel the plan has often been adopted of making the furnace walls hollow and cooling them by the air used for combustion. Such walls have not generally been used for mechanical stoker plants, but the alternative has commonly been the use of a rather expensive form of brickwork in order to prevent the bulging of the walls and excessive repairs.

More recently, however, another plan has been adopted for protecting these walls, and that is to line them with Murray water-tubes, which cover and completely protect the brickwork. On Plate V, Fig. 1, we illustrate a boiler of the Babcock and Wilcox type thus fitted. This is one of two which were installed some two years ago at the Hell Gate power station of the United Electric Power Company.

RESULTS OF TESTS ON BOILER NO. 51 EQUIPPED WITH SIDE WALL COOLING TUBES: HELL GATE STATION OF THE UNITED ELECTRIC LIGHT AND POWER COMPANY.

Boiler heating surface, 15,900 sq. ft.
Superheater surface, 7,430 sq. ft.
Fired by Taylor, 14 retort, single-ended underfeed stoker.
Grate area, 377·7 ft.

	1924.				
Date of Test	Jan. 28–29.	Jan. 29–30.	Feb. 5.	Feb. 15.	Feb. 25–26.
Duration of tests, hours	25	25	3	¾	25
Pressures and drafts:					
Superheater, lb.	262·5	262·6	262·2	244·0	263·7
Drum, lb.	277·8	271·9	291·0	280·0	267·0
Draft below economiser, ins.	1·55	0·75	2·30	3·3	0·48
Draft over fire, ins.	0·04	0·01	0·04	0·03	0·03
Temperatures:					
Steam, deg. F.	571·0	555·0	573·7	563·0	547·0
Gas leaving boiler and entering economiser, deg. F.	565·0	506·0	610·0	660·0	455·0
Gas leaving economiser, deg. F.	299·0	262·0	332·0	336·0	229·0
Feed water entering economiser, deg. F.	198·0	198·2	199·0	165·0	205·0
Feed water leaving economiser entering boiler, deg. F.	288·8	284·0	290·0	267·0	285·0
Quality of steam, per cent.	98·51	98·93	98·15	98·1	98·7
Superheat, deg. F.	160·7	144·7	163·7	159·0	136·0
Fuel analysis:					
Moisture in coal as fired, per cent.	4·01	4·01	—	—	2·5
Ash in coal as fired, per cent.	7·47	6·67	—	—	7·0
B.T.U. per pound coal as fired, B.T.U.	13,894·0	14,117·0	—	—	14,261·0
B.T.U. per pound dry coal, B.T.U.	14,474·0	14,697·0	—	—	14,626·0
Quantities:					
Coal per hour as fired, lb.	16,600·0	10,741·0	—	—	7,633·0
Dry coal per hour, lb.	15,934·0	10,310·0	—	—	7,440·0
Equivalent water evaporated per hour, lb.	178,059·0	125,585·0	238,720·0	289,459·0	93,278·0
Do. per pound coal as fired, lb.	10·73	11·69	—	—	12·0
Do. per pound dry coal, lb.	11·17	12·18	—	—	12·0
Rating and efficiencies:					
Evap. from and at 212 deg., lb./hr.	178,000·0	125,000·0	238,500·0	290,000·0	93,300·0
Do. per square foot of heating surface, lb./hr.	11·2	7·87	15·0	18·2	5·87
Combined efficiency of boiler, furnace, and superheater, per cent.	74·9	80·4	—	—	83·2
Combined efficiency of boiler, furnace, superheater, and economiser, per cent.	81·5	86·8	—	—	89·6
Gas analysis (last pass of boiler):					
CO_2, per cent.	13·51	12·55	—	15·2	11·69
O_2, per cent.	5·11	6·55	—	0·8	7·52
CO, per cent.	0·41	0·15	—	3·3	0·06
Leaving economiser:					
CO_2, per cent.	13·05	11·62	14·3	13·8	10·91
O_2, per cent.	5·41	7·53	3·5	1·1	8·45
CO, per cent.	0·63	0·13	1·1	4·0	0·04
Excess air, per cent.	38·3	58·5	—	—	71·6
	B.T.U. Per cent.	B.T.U. Per cent.			B.T.U. Per cent.
Heat balance per pound of dry coal:					
Heat per pound dry coal	14,474·0 100·0	14,697·0 100·0	—	—	14,626·0 100·0
Heat absorbed by water in boiler	9,712·4 67·1	10,687·5 72·8	—	—	11,075·5 75·8
Heat absorbed by steam in superheater	1,136·9 7·8	1,116·6 7·59	—	—	1,077·6 7·4
Heat absorbed by water in economiser	947·0 6·6	977·0 6·66	—	—	956·0 6·5
Necessary losses:					
1. Heat absorbed by moisture and water from burned hydrogen up to temperature of entering water	60·5 0·42	59·8 0·41	—	—	64·9 0·4
2. Heat absorbed by theoretical amount of dry gases up to temperature of entering water	352·0 2·43	362·0 2·46	—	—	386·5 2·6
Heat available for unit	14,061·5	14,275·2	—	—	14,174·6
Highest theoretical efficiency	97·2	97·2	—	—	96·9
Furnace and grate losses:					
1. Heat absorbed by excess air up to temperature of entering water	140·0 0·97	214·4 1·46	—	—	279·1 1·9
2. Heat loss through grate in ash	196·8 1·36	56·0 0·38	—	—	49·6 0·3
3. Heat loss due to CO	380·0 2·63	94·6 0·65	—	—	30·5 0·2
Heat available for economiser and boiler	13,345·5 92·4	13,813·0 94·0	—	—	14,266·8 97·6
Boiler and economiser—unit losses:					
Heat loss due to temperature of gases above entering water	777·0 5·37	678·6 4·62	—	—	576·1 3·9
Radiation, cinders and unaccounted for	771·4 5·33	450·5 3·06	—	—	130·2 0·9
Boiler efficiency combined	74·9	80·4	—	—	83·2
Combined boiler and economiser efficiency	81·5	86·8	—	—	89·6

The boiler in question has a heating surface in its ordinary tubes of 15,900 sq. ft. and, as will be seen from the test data we tabulate, a total "equivalent" evaporation of some 290,000 lb. of steam per hour was attained in one trial. As our illustrations show, the boiler is of the ordinary water-tube type, but of somewhat striking dimensions. The distance from floor level to the boiler top is no less than 60 ft. In a basement below the floor level accommodation is found for the gear by which the ashes and clinker are disposed of, whilst above the boiler top an economiser is fitted as shown. The superheater tubes are shown at A and the ordinary boiler tubes at B. The comparative size of the combustion chamber is very striking. The specially interesting feature lies, however, in the fact that the side walls of this chamber are completely lined with the Murray water-tubes, as is best seen in the sectional view, Fig. 2 (page 72). In this figure the upper half represents a section through the combustion chamber, and the lower portion a section through the neighbouring boiler at a higher level. A section through some of the Murray tubes is reproduced in Fig. 6. They are 4 in. in diameter and ¼ in. thick. They have welded to them steel ribs as indicated and when in place these ribs overlap as shown in Fig. 2, or still better in the drawings, Figs. 3 to 6, which also show how the baffle tile lying upon one of the ordinary boiler tubes is arranged. The overlapping of the flanges completely protects the brickwork behind the tubes, and eight months' experience at Hell Gate has shown that these flanges are kept so cool by conduction to the water-tube that there is no tendency for them to burn out. In fact, at the end of the interval named they were stated to be as good as new.

As the drawings show, the adoption of these tubes very materially reduces the brickwork which would otherwise have been required. Between the casing and the tubes are tiles or bricks some 2½ in. thick. These abut on the tubes and the 2½-in. space between them and the casing is filled in with "celinsulate." This forms merely a shield for the casing since the tube temperature cannot be much above that of the water inside the tubes or say not more than some 400 deg. F. Where unprotected brick walls are used they must withstand temperatures of nearly 2,800 deg. F. Hence to prevent overheating of the casing such walls must be very thick. In short, the saving in brickwork directly due to the adoption of the water-tube lining is nearly sufficient to pay for the tubes, and, of course, there is no comparison in the matter of maintenance costs, which, with the tubes, are almost nil. These tubes also add very materially to the heat-absorbing capacity of the boiler. They are exposed to the direct radiation of the burning fuel and, as is now well recognised heat transfer by high temperature radiation is the most efficient of all methods.

Comparative tests at the Hell Gate station of the boiler illustrated, which had, as stated, an ordinary tube surface of 15,900 sq. ft., with a boiler of the same general type, and having 18,500 sq. ft. of heating surface, but not fitted with the Murray tubes, showed that when both boilers were evaporating some 150,000 lb. of water ("from and at" 212 deg. F.) the gases from the boiler having the Murray tubes were delivered at a temperature 150 deg. F. lower than from the other boiler. On the basis of this and other tests, the engineers of the New York Edison Company estimate that the Murray tubes were generating between 60 and 80 lb. of steam per sq. ft. per hour of heating surface exposed.

The boiler efficiencies attained have been most satisfactory, as is shown by the test figures reproduced in the annexed table. Here it will be seen that in the case of the test made on Febuary 15, in which steam was generated at the rate of over 18 lb. per sq. ft. of the heating surface of the ordinary boiler tubes, the temperature of the gases leaving the boiler was only 660 deg. F., and this was reduced to 336 deg. F by the passage through the economiser.

Again, in the trials of January 28, and 29, an efficiency of 81·5 per cent. was obtained, reckoned on the higher calorific value of the fuel and the rate of evaporation "from and at 212" was about 11 lb. per sq. ft. of heating surface. In this case the gases left the boiler at 565 deg. F. and the economiser at 299 deg. F. The fuel consumption on this test was, it will be seen, about 44 lb. per sq. ft. of grate area.

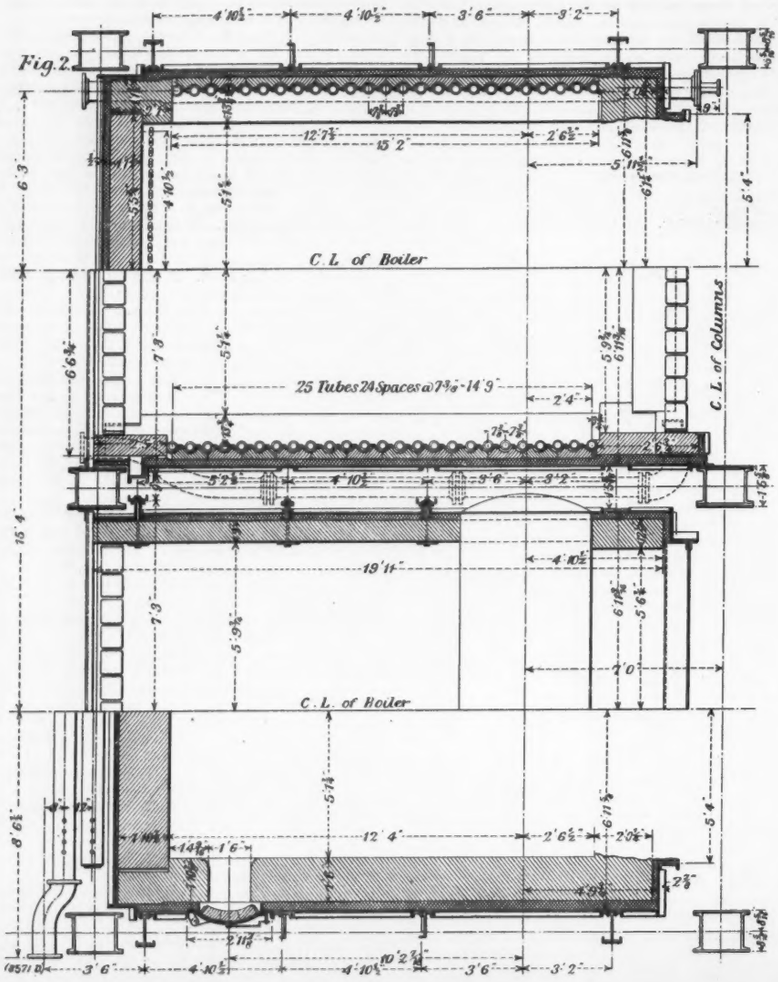
The Murray tubes open at the bottom into a horizontal header C (Fig. 1), which is coupled up by the piping shown with the bottom of the drum D. A second header E at the top of the tubes receives the water and steam from the tubes and discharges it into the drum a little above the water level there.

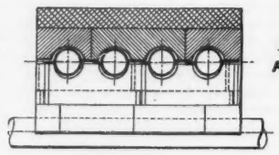
Some further notes on this boiler may be of interest. The top of the boiler forms a flat floor, as indicated in Figs. 1 and 8. This spans the whole width between side walls, a distance of some 11 ft., the details of its construction being shown to a large scale in Fig. 8.

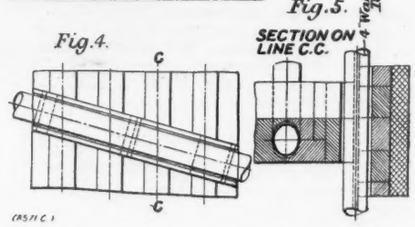
The boiler is coal fired, the fuel being fed in from

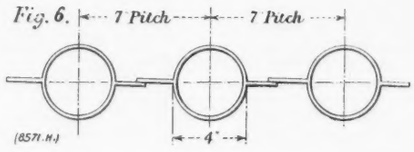
WATER-LINED FURNACES AT THE HELL GATE POWER STATION.

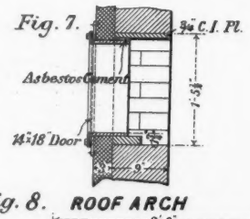
CONSTRUCTED BY MESSRS. THOMAS E. MURRAY (INC.), NEW YORK, U.S.A.











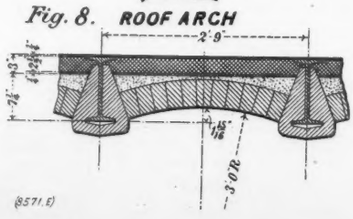


FIG. 9.

FIG. 10.

WATER-LINED COMBUSTION CHAMBER AT SHERMAN CREEK STATION, NEW YORK EDISON CO.

CONSTRUCTED BY MESSRS. THOMAS E. MURRAY (INC.), NEW YORK, U.S.A.

Fig. 11.

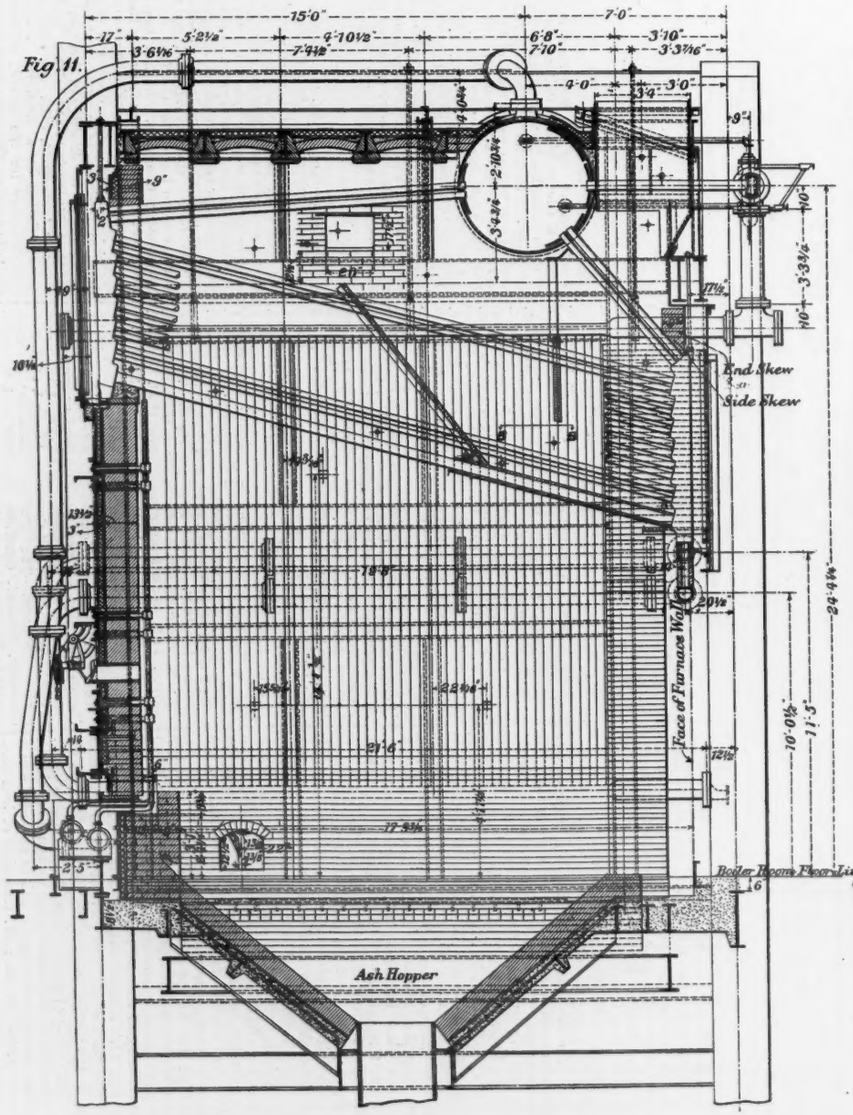
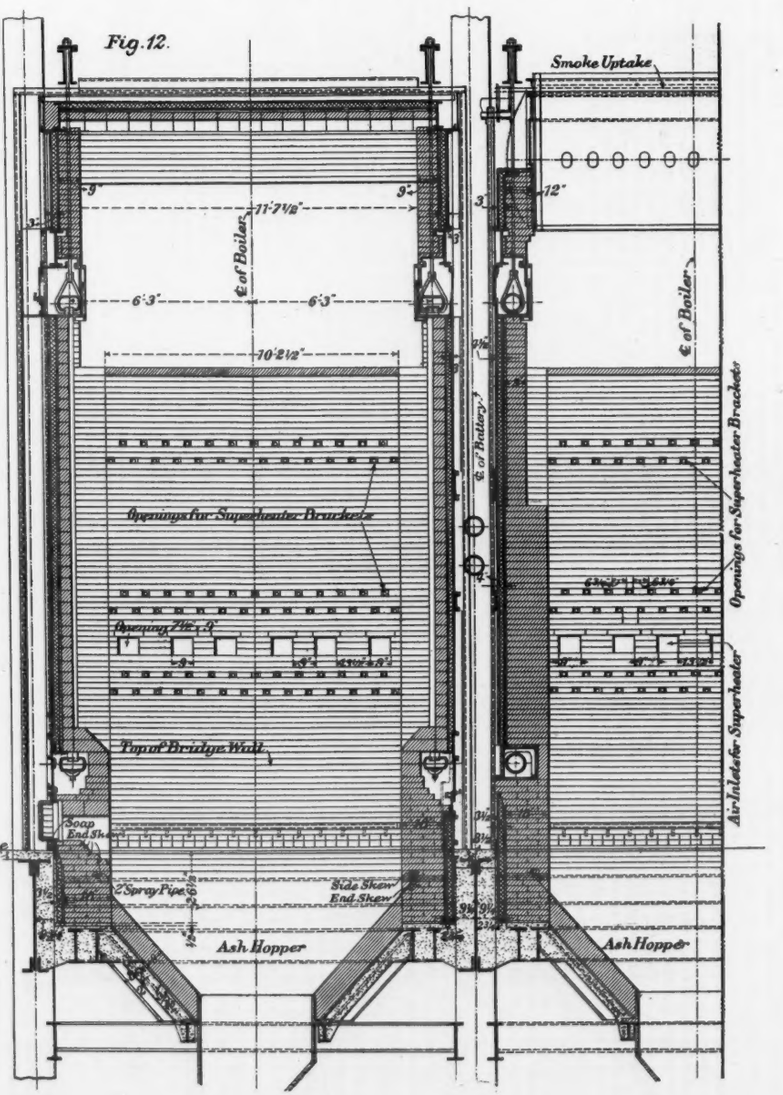


Fig. 12.



multiple retort stokers. A hopper at F receives cinders falling through the grate, whilst the clinker and ash are delivered over the tail of the grate to a set of crushing rolls which break it up into such a size that they can be readily carried away by the flow of water which is maintained along the trough at G Fig. 1. To keep the rolls cool a steady stream of water is directed on to them from an hydraulic main. Masses too large to pass the rolls are got rid of by opening out the flaps shown at H by the worm and sector represented on the left.

Figs. 9 and 10 are reproduced from photographs of the interior of the combustion chamber. These were taken after four months' hard work. The view represented in Fig. 9 was taken looking across the furnace, from the bottom end of the stoker; that is to say, from the place where the ashes are dumped; whilst the other view was taken with the camera pointed diagonally across the furnace and shows one of the Murray protected side walls and part of the end walls. It may be added that in some recent installations the Murray tubes are extended over this end wall as well as over the side walls.

As indicated, the Hell Gate boilers are fired with ordinary coal, but the same system of protection has been used for furnaces fed with powdered coal.

Sections through a Springfield boiler, thus equipped, at another of the New York Edison Company's stations, are reproduced in Figs. 11 and 12, page 73. Here the relative size of the combustion chamber as compared with the rest of the boiler is still more striking.

Messrs. Thomas E. Murray (Inc.), New York, N.Y., U.S.A., were responsible for the two installations above referred to, particulars of which we are able to give through the courtesy of The Underfeed Stoker Company, Limited, Aldwych House, Aldwych, London, W.C. 2, who hold a licence for the Murray tubes, in this country.

SPONGE IRON; ITS USES AND PRODUCTION.

IF a piece of iron oxide is completely reduced at a temperature low enough to prevent fusion taking place, the metallic iron resulting is very finely porous and exposes a very large surface of iron. This material is what is termed "sponge iron" and chemically is very reactive. It will precipitate copper, lead and numerous other metals from solutions much more rapidly than scrap iron or pig iron, and consequently its use ensures an increase of the capacity of the plant. For the hydro-metallurgy of low-grade copper and complex ores, sponge iron is likely to become of common application. The production of steel by a direct process, that is without the intermediate production of pig iron, has frequently been suggested, and it is thought that success may be possible with sponge iron as the basis. When it is remembered that it is possible to make sponge iron cheaply from iron ore and low-grade coal, and that it probably may be convertible into steel in the electric furnace at low cost, in small or large quantities, it will be appreciated that the substance may become of considerable importance.

Iron oxides may be reduced by heating with either gaseous or solid reducing agents, the commercially important ones being carbon monoxide and carbon. We learn from the "Reports of Investigations on the Production of Sponge Iron," conducted for the American Bureau of Mines at the North West Experiment Station, Seattle, by Messrs. C. E. Williams, E. P. Barrett and B. M. Larsen, that mixtures of carbon and ferric oxide, when heated under a very high vacuum, gave very much slower reduction than when heated under atmospheric pressure, indicating that the reduction took place essentially in the gas phase. The minimum temperature for rapid reaction of carbon dioxide and carbon was found to be 850 deg. C. to 875 deg. C., and in ore-coal mixtures maintained above this range strongly reducing conditions were automatically maintained. While reduction of iron oxide with carbon under this temperature condition was very largely endothermic, reduction with carbon monoxide gas took place from as low a temperature as 600 deg. C., and up to the fusion point of the oxides, and the reaction was slightly exothermic. Theoretically, the gaseous reduction process would seem to have the advantage, but in the development of a commercial process difficulties were found in large-scale work which were much more complicated to deal with than the simple heating of ore-coal mixtures.

In tests with a small direct-fired rotary kiln it was found that with 40 or more parts of coal to 100 parts of ore in the charge and heating by the use of an oil flame, regulated to pass directly over the rolling charge, that when the oil flame gave some carbon monoxide in the gases strongly reducing conditions prevailed and a 90 per cent. to 100 per cent. reduction of iron took place. A two-diameter continuous kiln was later designed, and after experiments had been conducted with it, a larger kiln was built and operated successfully at the plant of the Tintic Milling Company, of Silver City, Utah. This fire-clay lined kiln was inclined at a slope of ½ in. to a foot and was rotated at 2 r.p.m. The charge of ore and coal, ground to a mining 6-mesh, passed, in a bed of 2 in. to 3 in. depth, through the 22-ft., preheating section, the total passage taking between 15 and 20 minutes. Here the volatiles were given off and the charge reached a temperature of 900 deg. C. In the next part, which was of larger diameter and 5 ft. long, the layer was 13 in. to 15 in. depth and was maintained at a practically constant temperature of 900 deg. C. to 1,000 deg. C. In about one hour the reduction of the iron oxide was completed. Continuous discharge through a 3-in. pipe was arranged for, and the sponge iron was passed at an angle through the end wall into a cooling chamber below the furnace. Magnetic separation was then resorted to, to get rid of the excess carbon and coal ash. The capacity of this furnace was 3·5 tons of metallic iron per 24 hours. It gave a concentrate containing 80 per cent. iron and with 90 per cent. to 97 per cent. of the iron reduced to the actual metallic form. It was found that close regulation of the charge temperature to the range 925 deg. C. to 950 deg. C. was important if regular and continuous working was desired. Further work is being conducted on a fairly large commercial scale to find the data necessary to design the best type of kiln and to obtain improvements in the economy of working.

BOOKS RECEIVED.

Transactions of the Institution of Naval Architects. Vol. LXVI. 1924. Edited by R. W. DANA, M.A., M.Inst.C.E. London: Offices of the Institution.

Reinforced Concrete Beams in Binding and Shear. By OSCAR FABER, D.Sc., M.Inst.C.E. London: Concrete Publications, Limited. [Price 9*s.* net.]

La Balistique Extérieure. By J. OTTENHEIMER. Paris: Armand Colin. [Price 7 francs.]

Die Methoden der Theoretischen Physik. By FELIX AUERBACH. Leipzig: Akademische Verlagsgesellschaft, M.B.H. [Price 15 gold marks.]

Grundbegriffe der Mechanischen Technologie der Metalle. By Dr. Ing. GEORG SACHS. Leipzig: Akademische Verlagsgesellschaft, M.B.H. [Price 13 gold marks.]

Handbuch der Radiologie. Vol. VI. *Die Theorien der Radiologie.* Leipzig: Akademische Verlagsgesellschaft, M.B.H. [Price 40 gold marks.]

Metallurgy: An Elementary Text-book. By E. L. RHEAD, M.Sc., F.I.C. London: Longmans Green and Co. [Price 7*s.* 6*d.* net.]

Drawing Office Practice. By H. PILKINGTON WARD, B.Sc. London: Sir Isaac Pitman and Sons, Limited. [Price 7*s.* 6*d.* net.]

United States Bureau of Labor Statistics. Bulletin No. 359. *Proceedings of the Tenth Annual Meeting of the International Association of Industrial Accident Boards and Commissions. St. Paul, Minnesota, September* 24–26, 1923. Washington: Government Printing Office. [Price 20 cents.]

United States Geological Survey. Mineral Resources of the United States. II: 2. *Magnesium and its Compounds in* 1923. By J. M. HILL and G. F. LOUGHLIN. II: 3. *Strontium in* 1923. By G. W. STOSE. II: 4. *Flourspar and Cryolite in* 1923. By H. W. DAVIS. II: 32. *Petroleum in* 1922. By G. B. RICHARDSON. Washington: Government Printing Office.

United States Geological Survey. Bulletin No. 758. *Bibliography of North American Geology for* 1921–1923. By J. M. NICKLES. [Price 25 cents.] Professional Paper No. 127. *The Composition of the Earth's Crust.* By F. W. CLARKE and H. S. WASHINGTON. [Price 20 cents.] Washington: Government Printing Office.

La Vol à voile Dynamique des Oiseaux. By LOUIS BREQUET. Paris: Gauthier Villars and Cie. [Price 8 francs.]

The Failure of State Railways. By HAROLD COX London: Longmans Green & Co. [Price 6*d.*]

A Comprehensive Treatise on Inorganic and Theoretical Chemistry, Vol. V. B.Al, Ca, In, Tl, Sc, Ce, and Rare Earth Metals, C, Part I. By J. W. MELLOR, D.Sc. London: Longmans Green and Company. [Price 3*l.* 3*s.* 0*d.* net.]

Diesel Engine Design. By H. F. P. PURDAY, B.Sc. Second edition. London: Constable and Co. Limited. [Price 21*s.* net.]

United States Geological Survey. Mineral Resources of the United States (Preliminary Summary). Introduction by F. J. KATZ. *Statistics.* By M. B. CLARK. I: 1 *Gold, Silver, Copper, Lead, and Zinc in the Eastern States in* 1923. *Mines Report.* By J. P. DUNLOP. I: 2. *Platinum and Allied Metals in* 1923. By J. M. HILL. I: 3. *Bauxite and Aluminium in* 1923. By J. M. HILL. Washington: Government Printing Office.

CONTRACTS. — The Howden-Ljungström Preheaters (Land) Company, Limited, have received orders for the supply of three air preheaters for service at the works of the Inveresk Paper Mill Company, Limited, of Musselburgh, Scotland.—The British Thomson Houston Company, Limited, electrical engineers and manufacturers, of Rugby, have received a thirteenth order for tramcar equipment from the Manchester Corporation Tramways Department.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—While signs of improvement in the more favoured sections are not wanting, those who were disposed to place too literal a construction on forecasts of new year expansion are likely to be disappointed, at least so far as the opening weeks are concerned. Heavy steel has still considerable headway to make before plants with high maintenance costs can be profitably employed, particularly having regard to the low ratio of profits on running contracts. Rolling mills and heavy forges are doing moderately well on the whole, though the tonnages specified by individual buyers are low as compared with the normal average. Light foundries supplying castings to the building trade, stove grate makers and sanitary engineers are benefiting from local housing enterprise. This is not confined to the municipal authorities, but is seen in the wider activities of private builders. Some armament work is in hand, but gross requirements are nothing like sufficient to enable specialised organisations to operate profitably. An encouraging sign is the tendency shown by steel producers to enter into advanced booking for semi-finished materials. Some of the tool trades are making fairly satisfactory headway so far as output is concerned, though enterprise is hampered by rising tariffs in foreign markets and by the keenness of home and foreign competition. The proposals embodied in the new Government Bill to revise French Customs tariff duties would have the effect of more than doubling the cost of some of the leading Sheffield products to French buyers. Makers of tramway rails and points and crossings, and tramcar and omnibus builders are closely watching the trend of developments with regard to passenger transport. Motor 'buses appear to be increasingly in demand for connecting outlying areas and less densely populated urban districts with busy centres of commerce and industry. Sheffield Corporation has decided to pull up its Petre-street tramway track and build a roadway through into Grimesthorpe on which will be run a service of double-decked covered-in motor 'buses. The Corporation has also acquired a private 'bus service enabling Sheffield people to reach some of the beauty spots of Derbyshire, and on the Yorkshire side has opened a 'bus route to Penistone. Representatives of the crucible steel trade, the file and saw trades and the engineers tool trade are preparing evidence for submission to the Committee appointed by the Government to inquire into British industry and trade.

South Yorkshire Coal Trade.—Business generally is on a slightly broader basis than during the closing weeks of last year, and on the whole current prices are firmly held. Many complaints are heard of the weakness of the demand for house coal. Steam coal pits are again working regularly, and are sending big tonnages inland, mainly on railway account. The colliery position has further improved from the steady absorption of surpluses of cobbles and nuts, though there are more sellers than buyers of coking smalls. Deliveries of furnace and foundry coke have increased. Producers complain that current quotations are largely unprofitable. Quotations:—Best branch handpicked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 20*s.* to 23*s.* 6*d.*; Derbyshire hards, 19*s.* 6*d.* to 22*s.*; rough slacks, 9*s.* 6*d.* to 12*s.*; nutty slacks, 8*s.* 6*d.* to 10*s.* 6*d.*; smalls, 4*s.* to 6*s.* 0*d.*

ELECTRIFICATION OF SOUTH AFRICAN RAILWAYS.—The contract for the electrical equipment of the rolling-stock required by the electrification of the suburban lines of the South African Railways in the neighbourhood of Cape Town has been awarded to the English Electric Company. The lines to be electrified are those from Cape Town to the naval port of Simonstown and the seaside resorts of Kalk Bay and Muizenberg, on False Bay, and from Cape Town to Sea Point. The contract is of the value of between 300,000*l.* and 400,000*l.*, and includes electrical equipment of 83 motor coaches and 133 trailer coaches, to be operated on a 1,500-volt, direct-current system. The control gear is the "English Electric" standard type, which has already been adopted by a great number of other railways, including the Great Indian Peninsula Railway and the Japanese Government Railways.

PERSONAL.—Mr. A. W. A. Chivers, of the British Electrical Federation, Limited, has been re-elected President of the Diesel Engine Users' Association for the year 1925.—The receiver for the debenture holders of the Stringertype Manufacturing Company, Limited, has informed us that he had disposed of all the patterns, together with the jigs and tools, of the "Stringertype" surface grinder to the Dowdings' Machine Tool Company, Limited, of Bush House, Aldwych, London, W.C.2, who will in future transact all business relating to this machine.—We learn that the Wollaston Gas Producers (Manchester) Company, Limited, has taken over the office and present staff of Mr. T. Roland Wollaston, consulting engineer, at Lord's-chambers, 26, Corporation-street, Manchester. Mr. Wollaston will, however, continue in business as a consultant as before.—It is announced by the Ministry of Transport that Mr. Harry Booth is retiring from the office of Electricity Commissioner on January 24, 1925. He will, however, continue his association in a consultative capacity with the Commissioners for the present.—Sheffield Steel Products, Limited, of Templeborough Works, Sheffield, have acquired the sole manufacturing and selling rights of the H.B. self-loading and self-tripping trailer in the United Kingdom.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Statistically the Cleveland pig-iron trade is in quite a healthy state, stocks being considerably oversold, and there is hope and belief that the increased output by the blowing-in of an additional furnace will be absorbed. Notwithstanding these favourable conditions prices tend downward. Home demand keeps fairly good, but overseas trade is still very disappointing. There seems likelihood of America making a few more purchases here, but inquiries from the Continent continue few and small. Customers claim they can readily purchase No. 1 at 85*s.* 6*d.*, and No. 3 g.m.b. at 81*s.* 6*d*; whilst foundry 4 is no more than 80*s.*, and No. 4 forge is on sale at 79*s.* 6*d.*

Hematite.—Producers of East Coast hematite have considerable unsold stocks, and supplies for the market are being increased by the re-kindling of two furnaces at the works of Messrs. Gjers, Mills. Hope is entertained, however, that demand will improve, and makers are slow to acknowledge actual fall in quotations. At the same time sales of Nos. 1, 2, and 3 have been made at 87*s.* 6*d.*, and customers state they can place orders at below that figure. No. 1 is quoted 6*d.* above mixed numbers.

Foreign Ore.—There is very little doing in foreign ore. Sellers still base market quotations on best rubio at 22*s.* 6*d.* c.i.f. Tees, but it is understood that contracts can be arranged on lower terms.

Blast-furnace Coke.—The fairly good local demand for Durham blast-furnace coke is met by very ample supply, and good average descriptions are round about 24*s.* 6*d.* delivered to consumers in this district.

Blast-furnacemen's and Ironstone Miners' Wages.—Following on last week's reduction of 6½ per cent. in North-East Coast blast-furnacemen's wages, lowering wages from 18¾ per cent. above the standard to 12½ per cent. above the standard, the announcement is made that as from the 26th inst. Cleveland ironstone miners' wages will be reduced by 8 per cent., lowering wages from 78 per cent. above the standard to 70 per cent. above the standard.

Manufactured Iron and Steel.—Little new is ascertainable concerning manufactured iron and steel. The sale of semi-finished material is slow, and prices are rather easier. Demand for finished steel is only moderate, but the orders to be given out by the railway companies should strengthen the position. Among the principal market quotations are: Common iron bars, 12*l.*; iron rivets, 14*l.* 5*s.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 9*l.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.*; steel, ship, bridge, and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy sections of steel rails, 9*l.*; fish plates, 12*l.* and galvanised corrugated sheets (24-in. gauge in bundles), 17*l.* 10*s.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

Globe Collieries, Limited.—The mortgagees of the Globe Collieries, Limited, have appointed Mr. R. A. Richards, incorporated accountant, Cardiff, as receiver, and Mr. Richards has appointed Mr. G. Fred Evans as manager. The Globe Collieries, Limited, were one of the undertakings associated with Messrs. Harrisons Sons and Co., Limited, Cardiff, who have decided to go into voluntary liquidation. The Globe Collieries are situated in the Swansea anthracite area and work seams covering 1,226 acres, with an annual output of about 80,000 tons.

The Coal Trade.—A good arrival of shipping which was delayed by the recent gales has increased the volume of business passing on the market and for the moment improved the position of collieries generally. With supplies of tonnage in dock to meet their requirements salesmen have not been so ready to grant concessions for spot loading, and prices as a result have developed a steadier feeling, though weak spots are still to be found. New business has been quiet, as both salesmen and operators are content to follow a waiting policy and work on a hand-to-mouth basis. Best Admiralty large is about steady at 27*s.*, with seconds relatively stronger at 25*s.* to 26*s.* 6*d.*, and Monmouthshires from 23*s.* to 25*s.* Dry large coals, however, are in little request on the basis of 26*s.* 6*d.* for bests and 24*s.* 6*d.* for ordinaries, while bituminous coals, too, are only in moderate demand. Smalls are steady, with best steams from 16*s.* to 16*s.* 6*d.*, and cargo sorts round 14*s.* 6*d.* Exports of coal as cargo last week totalled 430,300 tons, against 301,830 tons in the previous week.

North's Navigation Collieries, Limited.—Sir William Carruthers has to-day elected a director of North's Navigation Collieries (1894), Limited.

Iron and Steel.—Exports of iron and steel goods from South Wales last week totalled 15,911 tons, compared with 2,135 tons in the previous week. Shipments of tinplates and terneplates amounted to 7,329 tons, against 1,339 tons; blackplates and sheets to 4,983 tons, against 351 tons; galvanised sheets to 3,070 tons, against 176 tons; and other iron and steel goods to 529 tons, against 270 tons. Meantime, the general demand is showing signs of improvement, and more enquiries are circulating, especially from the Continent.

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—To-night at 7 p.m. at Storey's-gate, S.W.1. Informal Meeting. Discussion on "Transportation in Engineering Works," introduced by Mr. W. S. Crabtree. Monday, January 19, at 7 p.m. Graduates Section. "Turbo-Blowers," by Mr. A. J. D. Humby, B.Sc. Friday, January 23, at 6 p.m. Reports to the Cutting Tools Research Committee: "Flow and Rupture of Metals During Cutting," by Mr. Walter Rosenhein, D.Sc., F.R.S. and Mr. A. C. Sturney, B.Sc. and "An Experimental Study of the Forces Exerted on the Surface of a Cutting Tool," by Mr. T. E. Stanton, D.Sc., F.R.S., and Mr. J. H. Hyde.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night at 7.30 p.m., at 39, Victoria-street, S.W.1. "The Hexaphase System and the Compensated 3-Phase System for 150,000 volts Transmission with Records of Test," by Major A. M. Taylor. Friday, January 23, at 7.30 p.m. Lecturette. "Boiler House Records and their Practical Value," by Mr. R. H. Parsons.

THE SOCIETY OF CHEMICAL INDUSTRY: LONDON SECTION.—To-night at 8 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C.2. Joint Meeting with the Chemical Engineering Group. "The Low Temperature Treatment of Bituminous Materials," by Mr. T. W. Stainer Hutchins.

THE BRADFORD ENGINEERING SOCIETY.—Monday, January 19, at 7.30 p.m., at the Bradford Technical College, Great Horton-road. Lecture, "Hydraulic Machine Tools and Power-Saving Appliances," by Mr. G. Bull.

THE ROYAL SOCIETY OF ARTS.—Monday, January 19, at 8 p.m., at John-street, Adelphi, W.C.2. Cantor Lectures, "Radiological Research—A History." (Lecture 1), by Mr. V. E. Pullen. Wednesday, January 21, at 8 p.m. Ordinary meeting. "Irish Glass, Old and New," by Mrs. Graydon-Stannus.

THE INSTITUTE OF TRANSPORT.—Tuesday, January 20, at 5.30 p.m., at the Institution of Electrical Engineers, Victoria-embankment, W.C.2. Lecture, "Principles Governing Railway Rates," by Mr. Roger Gibb.

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, January 20, at 6.30 p.m., at 85–88, The Minories, Tower-hill, E.1. "Oil Fuel Burning in Steam Generator and Furnace," by Engineer Lieut. A. Marsden, R.N.

THE ASSOCIATION OF DROP FORGERS AND STAMPERS.—Tuesday, January 20, at 7.30 p.m., at the Chamber of Commerce, Birmingham. Lecture, "Measurement of Temperature in Industrial Operations," by Mr. C. M. Walter, D.Sc.

THE SOCIETY OF GLASS TECHNOLOGY.—Wednesday, January 21, at 2.30 p.m., at the University, Edmund-street, Birmingham (A) Special General Meeting. Final Consideration of revised "Constitution and Rules." (B) Ordinary meeting. General discussion on "The Design of Modern Glass Melting Furnaces." The subject will be introduced by the following Papers (*a*) "A Note on New Ideas for Tank Furnace Design," by Mr. Th. Teisen, B.Sc. (*b*) "Some Recent Developments in Furnaces and Gas Producers for Glass Works," by Mr. James S. Atkinson.

THE RADIO SOCIETY OF GREAT BRITAIN.—Wednesday, January 21, at 6 p.m., at the Institution of Electrical Engineers, Victoria-embankment, W.C. 2. Address by Sir Oliver Lodge, D.Sc., LL.D., F.R.S., on "Matter and Radiation."

THE ROYAL METEOROLOGICAL SOCIETY.—Wednesday, January 21, at 7.30 p.m. Annual General Meeting. Address on "The Present Position of Meteorology and Meteorological Knowledge," by Mr. Charles J. P. Cave, M.A., President.

THE INSTITUTION OF PRODUCTION.—Wednesday, January 21, at 7.30 p.m., at the Engineers' Club, Coventry-street, W. 1. "Instruments and Gauges," by Mr. H. A. Randall.

THE MIDLAND INSTITUTE OF MINING ENGINEERS.—Thursday, January 22, at 4 p.m., at the Queen's Hotel, Leeds. Discussion on "The Report on the Explosion at the East Pit of the Birley Colliery, Brighton," by Mr. Henry Walker. "The Collieries of the First Danube Steam Navigation Company (D.D.S.G.), near Pécs (Funfkirchen), Hungary," by Dr. J. Herczegh. "The Utilisation of Waste Heat and Surplus Gas from Coke Ovens," by Mr. I. C. F. Statham, B.Eng. "Mines (Working Facilities and Support) Act, Part I, 1923," by Mr. J. H. Cockburn.

THE ROYAL AERONAUTICAL SOCIETY.—Thursday, January 22, at 5.30 p.m., at 7, Albemarle-street, W. 1. Lecture, "Some Recent Work of the Aerodynamics Department, National Physical Laboratory," by Major R. V. Southwell.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 22, at 6 p.m., at Victoria-embankment, W.C. 2. "The Design of Electrical Plant, Control Gear, and Connections for protection against Shock, Fire and Faults," by Mr. H. W. Clothier.

THE INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Thursday, January 22, at 6 p.m., at the Chamber of Commerce, New-street, Birmingham. Students' Meeting. Discussion, "Concrete: Its Practical Use and Limitations," by Mr. H. C. Tow, M.Sc.

THE INSTITUTION OF STRUCTURAL ENGINEERS.—Thursday, January 22, at 8 p.m., at Denison House, 296, Vauxhall Bridge-road, S.W. 1. "The Structural Engineer in America: His Place and Influence," by Mr. Ernest McCullough.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, January 23, at 7.30 p.m., in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne. Lecture, "Railway Electrification in Switzerland," by Mr. E. A. Eborall.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, January 23, at 9 p.m., at Albemarle-street, W. 1. Evening Discourse will be delivered by Dr. A. W. Crossley on "Science and the Cotton Industry." Afternoon Lecture. Tuesday, January 20, at 5.15 p.m., Professor A. Fowler on "The Analysis of Spectra" (Lecture II).

THE HULL ASSOCIATION OF ENGINEERS.—Saturday, January 24, at 7.15 p.m., at the Municipal Technical College, Part-street, Hull. Lecture, "Feed Water Treatment," by Mr. Lewis.

THE SCIENTIFIC SOCIETY OF THE ROYAL TECHNICAL COLLEGE.—Saturday, January 24, at 7.30 p.m., at George-street, Glasgow. "Electric Driving by Austin Constant-Current Motors," by Mr. Gilbert Austin, M.I.E.E.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Work was resumed in the majority of the Scottish steel works last week, but bookings have not shown much in the way of an increase since the closing down at the end of the year. The volume of business to start on was, therefore, not heavy, and plant was only partially employed. Inquiries show signs of improving, but until some drastic change comes over the conditions now prevailing on the Continent the outlook here is likely to be somewhat obscure. The import of steel material continues fairly heavy, and the local works are experiencing a very limited demand from shipbuilders.

In the black sheet trade there is a fair amount of activity, and most of the works are fully employed. Recent bookings cover the output for the next few months, and inquiries are in circulation for further forward supplies. The prospects in this branch of the industry are quite encouraging. Prices show no change and the following may be taken as the current quotations:—Boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; and sheets, $\frac{7}{16}$ in. to ½ in., 12*l.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—No improvement can yet be reported in the West of Scotland malleable iron trade, and a poor start has been very general. With little work already booked, and not much of an accumulation of fresh business over the holiday period, the conditions at the works at present are not very bright. The better inquiry is encouraging, and it is hoped that we are on the eve of better times. The steel re-rolling sections are moving fairly well. Prices are steady, with "Crown" bars unchanged at 12*l.* per ton, delivered Glasgow stations.

Scottish Pig-iron Trade.—A dull tone prevails in the Scottish pig-iron trade, but there are signs—small though they may be—of a betterment coming along in the near future. A similar state was in evidence at this time last year, but little came of it, and 1924 has to be written down as a very disappointing year. Business all along was very poor and almost went from bad to worse. When the year opened the number of furnaces in blast was 44, but through labour troubles the number had fallen to 34 by the end of February, and to 15 at the time of the annual Fair Holidays in July. All that time the demand was so small that even the limited output could not be disposed of, and stocks were accumulating. Towards late autumn a slightly better feeling was noticeable, and when the result of the General Election became known more confidence began to prevail and some buying took place. As in many other industries the change for the better was short-lived, and during December conditions became, if anything, worse than before. The prices throughout the year were far from satisfactory, and marked a steady decline all through. The export trade was very poor and quite disappointing, and even now a revival in that direction is not discernible. Current quotations:—Hematite, 4*l.* 15*s.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 12*s.* 6*d.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at maker's works.

Scottish Pig-iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, January 10, amounted to 585 tons. Of that total 341 tons went overseas, and 244 tons coastwise. For the corresponding week of last year the figures were 556 tons overseas and 99 tons coastwise, making a total shipment of 655 tons.

OIL-ENGINE WORKING COSTS.—As a result of investigations carried out during the period 1923–24 by the Diesel Engine Users' Association, some further information on the cost of running oil engines is now available. Data collected from 34 Diesel or semi-Diesel installations engaged in the production of electrical energy throughout the United Kingdom indicate that with a total annual output of over 26,000,000 units and an average plant load factor of 13·3 per cent., the cost of each unit generated was 0·899*d.* The average total maintenance costs worked out for the stations under consideration, which have 112 engines of over 22,000 kw. combined power, at 0·96*l.* per kilowatt installed.

THE SALVAGE OF A FLOATING DOCK.

THE FALMOUTH DOCKS AND ENGINEERING COMPANY, LIMITED, CONTRACTORS.

(*For Description, see Page* 61.)

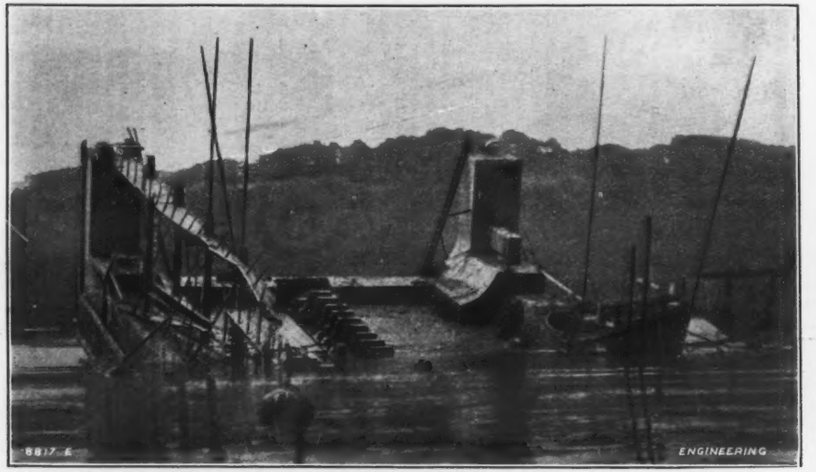


FIG. 6. FORE-END OF DOCK RAISED.

FIG. 7. DOCK RE-FLOATED WITH "RINGDOVES AID" SALVAGE SHIP ALONGSIDE.

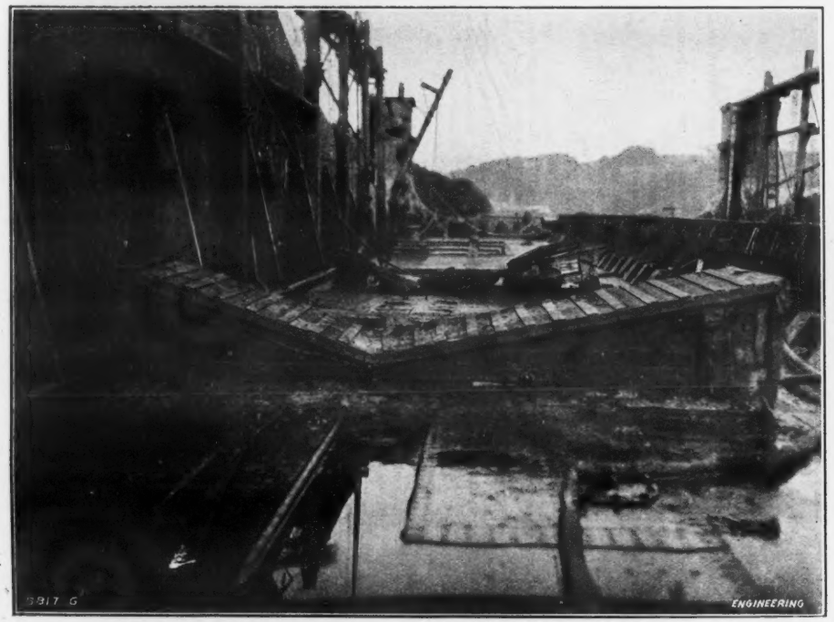


FIG. 8. TOP OF TANK, SHOWING REPAIR WORK DONE BY DIVERS.

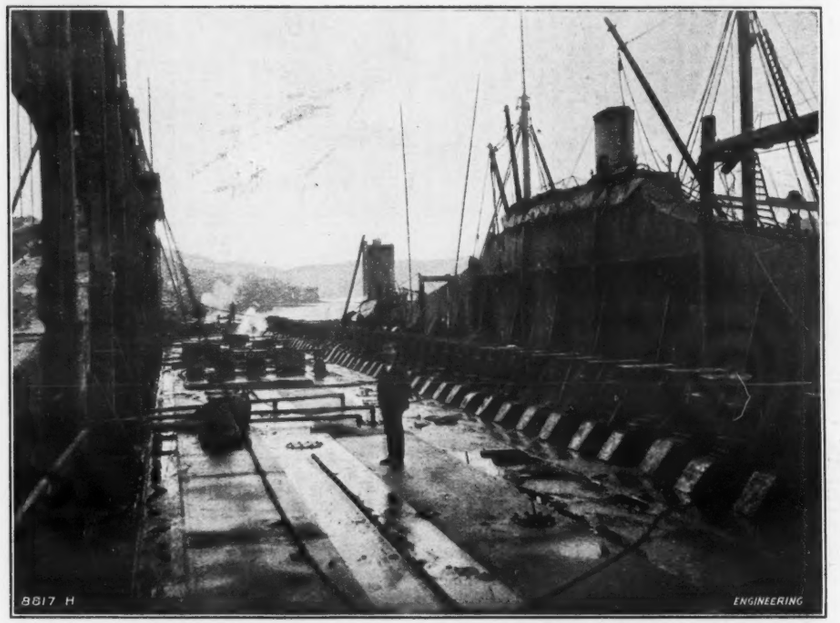


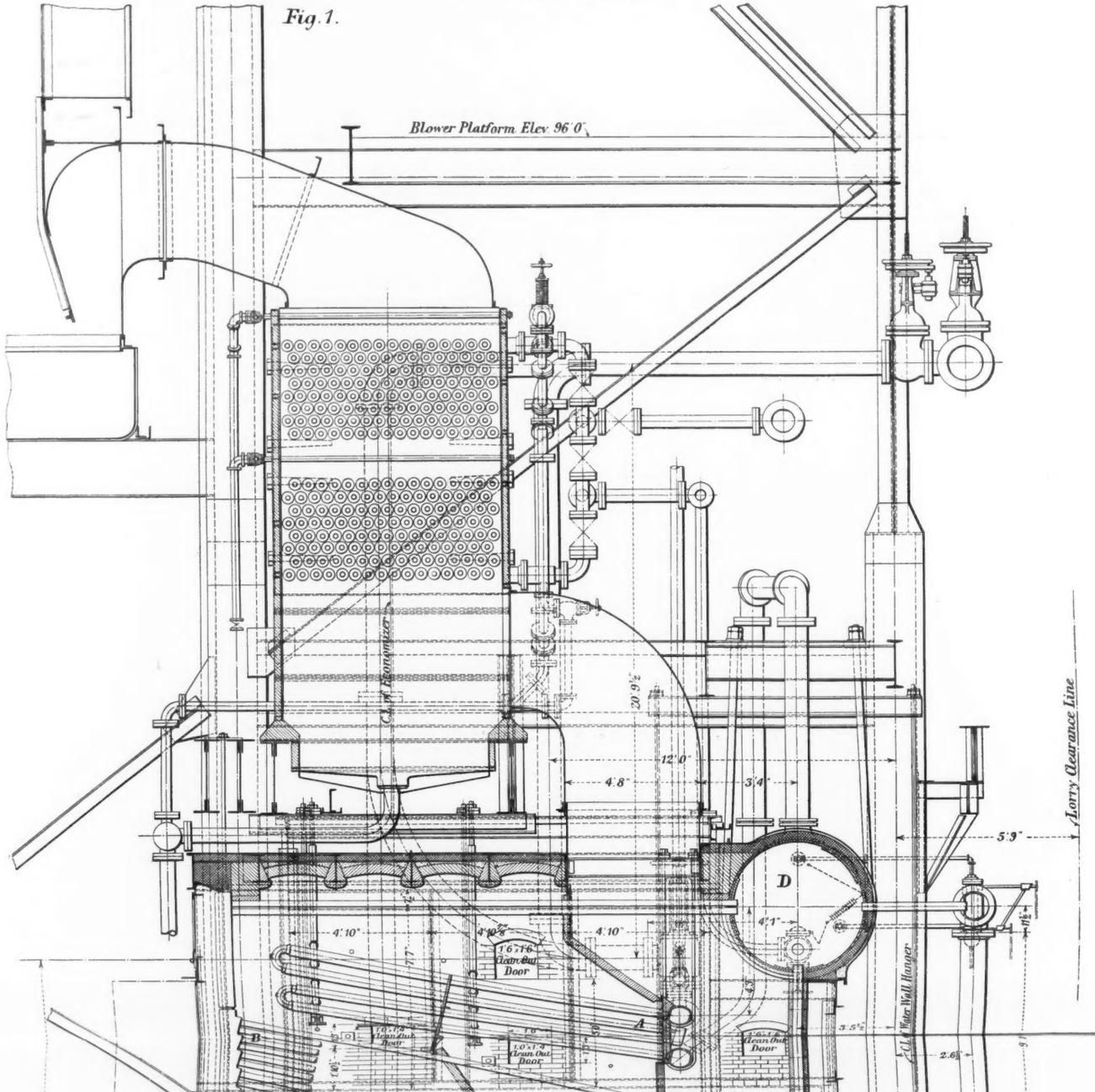
FIG. 9. VIEW FROM INSIDE OF DOCK AFTER RE-FLOATING.

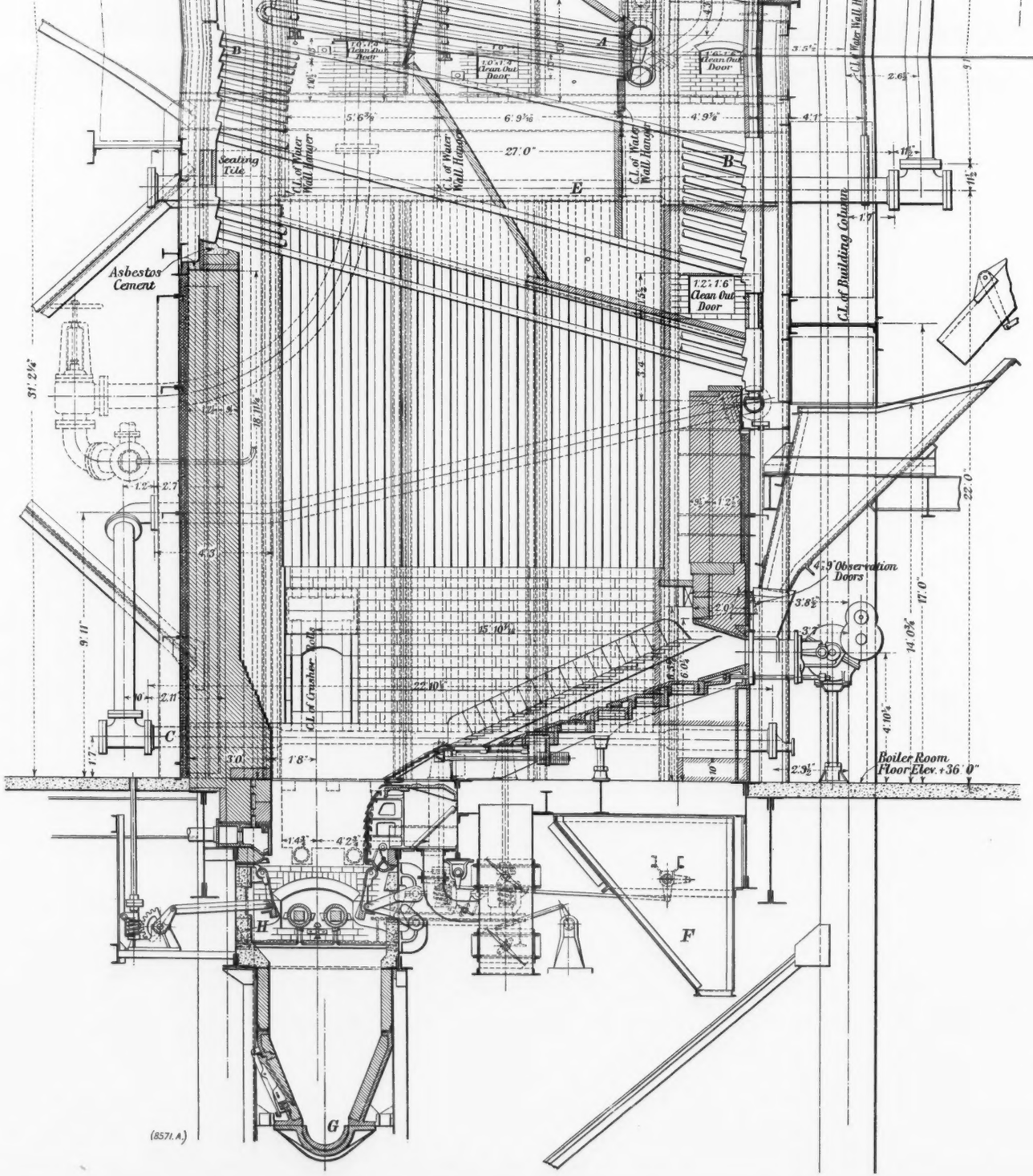
WATER-LINED COMBUSTION CHAMBER AT THE HELL GATE STATION OF THE UNITED ELECTRIC POWER COMPANY.

CONSTRUCTED BY MESSRS. THOMAS E. MURRAY (INC.), NEW YORK, U.S.A.

(*For Description, see Page* 71.)

Fig. 1.




Asbestos Cement
Seating Tile
C.L. of Water Wall Header
C.L. of Water Wall Hanger
C.L. of Building Column
C.L. of Crusher
1.2"x1.6" Clean Out Door
1.0"x1.4" Clean Out Door
4'-9" Observation Doors
Boiler Room Floor Elev. +36'-0"
A
B
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D
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H
(8571.A.)

ENGINEERING.

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Two-Page Plate.—WATER-LINED COMBUSTION CHAMBER AT THE HELL GATE STATION OF THE UNITED ELECTRIC POWER COMPANY.

ENGINEERING.

FRIDAY, JANUARY 16, 1925.

THE SUPPLEMENTARY RESERVE.

THE celerity and secrecy with which our Expeditionary Force was thrown into France in 1914 proved material factors in a moment of intense crisis, while the success with which the operation was conducted, without accident, it is universally agreed, is proof of the excellent organisation, careful preparation, and forethought which had been devoted to a possible call of this nature. Once landed overseas and faced with a task which required large-scale reinforcement, our Army was, however, far from happily placed, and throughout the war in the various theatres, the disadvantage was apparent of the technical branches having to work in what may be termed extemporised units. Attention was at first almost wholly concentrated on an ample supply of infantry reinforcements. When later it became recognised that these were of little value in the field without a large increase in the complementary branches, men were combed out of the battalions in which they had so willingly enlisted, and drafted to work more suited to their special qualifications, but much valuable time was always lost by all ranks in falling into the new organisation.

Inevitable under the circumstances, the effect of this course was very severely felt in some theatres of war and greatly handicapped operations in the early stages. The drawbacks of the method were so impressed upon officers in the field that very many were grievously disappointed to find that the reorganisation, subsequent to the cessation of hostilities, found no room for some skeleton scheme of expansion for the technical branches. Admittedly the War Office was faced with a herculean task when it had to clear up the several campaigns, return the bulk of the Army to civil life, reorganise the Regular Army, and, last but not least, comply with the national demand for rigid economy when all expenditure was productive of so little value. It was, further, natural that the question of the Regular Army should be tackled first, but it cannot but be a matter for regret that means were not found for keeping touch in some way with personnel who had given valuable service with the temporary forces, with a view to utilising their qualifications subsequently in some scheme of reorganisation. With the passing years the veterans of the Great War must naturally drop into the background, but there were many who at its close had the prospect of many serviceable years before them, and who could without difficulty have been influenced to retain some small measure of obligation. Instead they were allowed to drift completely away, and it looked as if, in the event of another war, we were to have to go through our lessons again.

The case has fortunately turned out not quite so bad as that, as the War Office has since taken the important step of supplementing some of the technical branches. In August last, Mr. Stephen Walsh being the Secretary of State for War in the Labour Ministry of the day, Army Orders 284/285 1924, were issued providing for a Supplementary Reserve for the Regular Army. While not going as far as we would like, in a direction which we shall indicate presently, this Reserve embraces branches of the services which the last war showed to be so gravely in default. The idea behind it very clearly is that when the regular forces require to be strengthened by the mobilisation of the Reserve, the force so added should be properly balanced, instead of showing a preponderance of infantry and a lack of the special services. The sections of this Supplementary Reserve of most interest to us are the units of the Royal Engineers. The strength authorised for these in August last amounted to 2,414 of all ranks in Army Troops Companies and E. and M. Companies, besides 3,303 officers and men for works services, light bridging parks, stores depots, &c. In addition to these, important provision was made for the Transportation Branch, to the number altogether of 3,303 officers and men. The Transportation section, to which we want specially to refer, falls into two categories. Category B, mainly organised in units covers provisionally 98 officers and 920 men. The bulk of these go to form two platelaying companies and one railway bridging company. Category C details are included chiefly in four railway operating companies, one advanced railway workshop company, one base railway workshop company, a railway stores company, movement and control staff, and one dock company. There are, of course, other classes in smaller numbers, but those we have named will show the essential character of this branch of the new organisation. Category B men are required to undergo annual training, but this is not required in the case of Category C.

The details we have given are a clear indication of the recognition of the fact that the Regular Army, expanded by the mobilisation of the Reserve, requires the co-operation of enlarged technical services. As regards transportation the four railway companies have been invited to assist in giving effect to the measure, and only on Friday last was it announced that the London and North Eastern Railway had agreed to form one platelaying company, one dock company, one section of a bridging company, headquarters and operating group, and two operating companies. Close upon the heels of this, however, came the announcement that the trades unions were opposed to the movement and were officially advising members against volunteering. The reason given was that it was feared that the men enlisted might be used in disputes between the railways and their employees. Such an attitude would be difficult to understand were it not for the fact that every day we have evidence that the world contains a certain number of persons whose peculiar attitude of mind causes them perversely to interpret every ingenuous action as prompted by some sinister motive or ulterior design.

It is not by any means the first time, of course that a section has put trades unionism before patriotism, but it is difficult to believe that the more level-headed men in the movement can approve of the present embargo. The agitation has unfortunately been made to coincide with the absence

from the country of Mr. J. H. Thomas, one of those who did yeoman service in the Great War, or, we believe, it would not have gathered such headway. The many Rolls of Honour of the railways testify to the fact that their men were as willing as any others to respond to the call of the years 1914-1918, and we do not believe that the bulk of the present employees will be deluded into reading into the present Order the suspicions of the Industrial Secretary of the N.U.R. Mr. S. Walsh himself is very emphatic on the clearness of the Army Order on the point raised. The language used is, in fact, the plainest English, not always chosen for Army Orders and instructions. A.O. 285/1924 specifically declares that "the liability to be called out in aid of the civil power will not, however, be enforced." It would be difficult to find words more definite than these, but if anything further were needed to dispel the fear which is supposed to have arisen it should suffice to point out that this very modest programme of the War Office asks for the enlistment of less than one-half of 1 per cent. of the total number of the employees of the companies. The classes vary, but taking the platelaying companies, it will be found that the strength of these represents only 0·8 per cent. of all the permanent way men. The absurdity must be apparent, therefore, of trying to argue that this Supplementary Reserve might be used with effect in the case of a national strike.

Far from there being harm in the institution of this reserve force, it is, we believe, the soundest national economy. We maintain only a moderate-sized Regular Army, and, such being the case, the best insurance policy we can adopt is to maintain it at the highest standard, ready to act on any sudden call. The reserve force is intended to assist in this, so that if expansion beyond the standing Army should become necessary, the first step in this may be taken without having immediately to fall back upon extemporised troops.

In view of the important place engineering and technical matters now hold in the larger military operations, the Supplementary Reserve programme appears to be extremely moderate. The last war proved that supplementary infantry could be trained and put in the field in a relatively short time. There was, however, difficulty with the officers and men for technical duties. Many of these were required in the early stages, and the work itself was satisfactorily performed by temporarily enlisted or commissioned civilians. Often, however, these were far less effective than they might have been owing to a lack of knowledge of military affairs and methods, organisation, discipline and so on. Their work would undoubtedly have been greatly facilitated had they been possessed of such knowledge at the start. From the institution of the Supplementary Reserve we conclude that this is now admitted in principle at least, and if this is so it would seem to be logical to carry matters further by forming a skeleton organisation ahead of the temporary enlistment of infantry, &c. We might thus have ready the nucleus technical staff for dealing with special units as formed. The last war showed, for instance, how many young engineers were required on the lesser jobs connected with pumping for both water supply and drainage, road making, electric plant, workshops, &c. How many of the younger members of our Institutions are to-day in any way prepared to drop suddenly, if need be, into this class of work combined with military duties? If these young fellows, whose technical knowledge would prove invaluable in the field, could be interested and given an insight into military life, organisation, King's Regulations, etc., in peace-time, by attaching them as supernumeraries either to Regular or Territorial units for training, they might be kept on a general list for special duty as the need arose. The points we now would make are that the young engineer whose chief asset in the field is his specialist professional knowledge, has few openings in the present scheme, though the last war proved that his services on a large scale were essential to successful operations, and that at no great cost the country might give these young men, in anticipation, some preliminary insight into military life and ways, so that if they were called upon they might prove effective practically from the start.

LONDON TRAFFIC.

WITH the advent of motor traction new problems were introduced into questions affecting the control of thoroughfares, for vehicles in this class are capable of rapid acceleration and retardation, which was not the case with the older types of conveyances. Where both types of traffic use the same streets, providing that the number of the vehicles is great, there can be no doubt that the slow-moving horse-drawn type is the cause of much of the congestion. Naturally the speed of the traffic, where the volume is great, is determined solely by the limited rate of progress of the slowest item in the stream. For this reason many demands have been made from time to time for the withdrawal of horse-drawn vehicles from the important arteries during the rush hours. This suggestion, with many others worthy of close attention, was brought up again by Mr. Alfred C. Bossom, an English-born resident in New York, when he read a paper on "London Traffic" before The London Society at a meeting held on Friday, January 9, in the Hall of the Royal Society of Arts, Adelphi, London.

For many reasons, the views of those who are not influenced by the considerations of local traditions, associations, or ties, are to be appreciated in dealing with problems such as that dealt with by Mr. Bossom, and it is because of this that we wish to call attention to his comments. He has had much to do with the design of the tall buildings or "skyscrapers" in New York and other American cities, the erection of which has undoubtedly caused great traffic congestion, with the result that the new regulations drawn up for their construction by the American authorities show a marked determination to curtail the heights to which they may be erected. It will be recognised that under these circumstances he has claims to be heard on questions relating to town planning, and the problems which uncontrolled development may create. It is of interest to note that Mr. Bossom unhesitatingly recommended that very high office structures should be prohibited in London. It was not on a question of appearance that he based his contention, but rather on the increase of traffic congestion which their presence caused. The great congestion of people entering or leaving a building at the same time he regarded as quite sufficient reason to restrict building heights in London.

A Traffic Control Board he considered for London to be essential, to undertake the organisation of single-way traffic, running in opposite directions in parallel streets as well as for the establishment of definite routes between particular places and for educating the public in the ways of safety. In New York where congestion had almost reached its limit, it was claimed that relief was found to be instantaneous once a definite system of control was instituted and enforced. Careful investigation was necessary in the case of London before any system of one-way traffic was established, because many of the streets were short and straight lengths were, in places, very rare. One-way traffic should only be instituted where a second street parallel to the first, and within a reasonable distance of it, is available. Actually, Mr. Bossom said, the irregularity of London streets had certain advantages in dealing with traffic problems, for there were no points in the City to which there were not at least two routes. Without definite control confusion was caused, but if certain areas were designated as only approachable along certain routes, one-way traffic could be established and the speed of movement materially increased.

The decentralisation of the markets, the erection of bridges for pedestrians across the roads at busy points, the institution of a signal system at crossings, and the enforcement of one-way turning from a side street into a main thoroughfare, to prevent the crossing of the traffic at such points, were also proposals relating to congestion relief, presented by Mr. Bossom for consideration. At important points the provision of tunnels to allow vehicular traffic to avoid the crossing of very busy thoroughfares was essential, he thought, in the development of any thorough system of organised traffic control to obtain increased speeds of travel. The cutting of subways, permitting easy movement below ground to outlying centres and with loops to join them, would very soon relieve the congestion in the streets, since those who experienced delays in going to and from their business would quickly come to utilise the subway facilities. The entire plan of underground development in this way should be reviewed by some independent body, and municipal support should be given to ensure the provision of this necessary means of rapid transportation.

In considering the views of Mr. Bossom it must be remembered that the Ministry of Transport has now been given very great freedom in dealing with the situation, and a London Traffic Advisory Committee has been established, to report on schemes which are thought, by them, to be advisable to relieve the trouble. One indication of activity was provided on Monday last when the Ministry of Transport issued a memorandum relating to omnibus traffic in the busy streets. Under the regulations referred to it is proposed to designate certain thoroughfares as "congested," and thereafter no additions to the omnibuses using them will be permitted. The streets thus classified so far, are all those in which the traffic troubles are already great. The question of reducing the numbers of those vehicles plying for public hire is now under consideration, and the Committee have been asked to advise on other steps which they regard as necessary in the public interest.

STATE-OWNED AND PRIVATE WORKS.

THE comparison between naval ship construction in State establishments and by private firms has for several years past formed the subject of discussions in France by the advocates of both alternatives. The question was dealt with in a paper on "The Industrialisation of Arsenals," by Mr. Lamouche, of the French Corps of Naval Architects, read at a recent meeting of the Association Technique Maritime et Aëronautique. It is also being taken up afresh by French technical journals and reviews. By "industrialisation," the author does not imply the handing over of the arsenals and dockyards of the country to private ownership, but giving them, what one may call, an every-day private works character.

The paper opens with a statement to the effect that in France, where industry is highly developed in all its branches, a large proportion of military orders can be quite rightly entrusted to privately-owned factories. The war, it adds, fully justified this procedure; but, on the other hand, the very valuable aid rendered to the country by private works during the wartime period led too hasily to the wrong impression that the State arsenals might be dispensed with altogether. This impression is based mainly on the cost price of units built by the arsenals compared with the price charged by private concerns for similar work. The author objects to such a comparison on the price basis. In his opinion an arsenal cannot be considered in the same light as a private works; the former, to use his own words, is essentially a "military finality" whilst the latter is purely an economic one. According to him, it is incorrect to compare two conceptions which he defines in one case as "the constant maintenance at its maximum actual and potential efficiency of a powerful organism for national defence," and, in the other, "the making of the highest possible profits." In this statement the author is hardly fair to private shipbuilding concerns.

We do not agree with him in regard to ignoring entirely the price factor when establishing a comparison in the matter of construction by the State and private concerns; this can quite legitimately be brought into the discussion, it may even be said to be the leading factor introductory to all the others.

It is, we believe, an established fact that in most naval countries, if not in all, a State-built ship is more costly to the nation than one built by a private company. A few years before the war the cost of manufacture in the French arsenals and dockyards was quite openly stated to be double that of private works. The arguments elaborated in the paper and even its title indicate that matters have not improved in this connection. Very few

dockyards are in a position to build a ship complete "from keel to truck"; almost all have to resort to private industrial concerns for a large portion of the material, machinery and equipment, this being obtained from the firm quoting the most favourable conditions consistent with the requisite high quality. This material, machinery and equipment is frequently a counterpart of similar work which the same company may have to construct for a sister-ship. Such being the case, the expensiveness of State arsenal work becomes still more striking.

The reason why a State-built ship is generally higher in cost than a privately-built one is difficult to enter into and is probably due to a multitude of causes. The plant, in its many varieties, of a dockyard may not invariably consist of the most modern type; this places the establishment in a comparatively inferior situation. A private works is more likely to keep abreast of the times in view of the fact that in much of its work it has to meet foreign competition. To take a case, an extreme one it is quite true, but one which obtained until a relatively recent date, in one State establishment the two ends of a connecting rod were roughed by a small-feed slotting machine, instead of by a band-saw, other machining work being done on similar lines. Methods of this kind cannot be expected to compete under present-day circumstances either in regard to cost or time.

The author contends that an arsenal is, or should be, primarily a centre in constant activity for the carrying out of studies, researches and experiments, with a view to improving the *matériel* in the Service; a centre always available for the construction, maintenance and repair of naval units, in which the criterion conformed to is the degree of military urgency and importance; it also is, or should be, a supply centre for all spare parts, stores and material so as to reduce to a minimum the time required for the series of operations which a ship may have to undergo in order to pass from a condition of unpreparedness to one of real efficiency as an active component part of a fleet; finally, an arsenal should serve as a centre for industrial mobilisation.

The description we reproduce above is an ideal one, implying an arsenal, or rather a number of such establishments maintained constantly with an equipment of the most modern appliances and machinery, a condition which cannot be met without a very great and ever-recurring outlay. Progress in naval ship construction has been due in the past to naval architects connected with private works quite as much as to those on the staff of the arsenals, if not to a greater degree. A private yard is able to repair the damaged hull of a ship quite as effectively as a State dockyard, and will probably do so in less time. The spare parts it would be desirable to store in order rapidly to meet an emergency are those which take the longest time to prepare. A merchant vessel has frequently been delayed in harbour many weeks owing to the necessity for replacing a broken crankshaft. A warship may require some corresponding heavy part at a critical period; this would have to be manufactured specially, for it is quite obvious that such parts as shafts and other heavy or intricate pieces of machinery cannot be manufactured in advance and kept in reserve in order to provide for contingencies. In any case machinery parts, heavy or light, can be manufactured when circumstances demand quite as rapidly in the nearest well-equipped factory as in a navy yard. As for industrial mobilisation, the late war has conclusively established the fact—as the author himself acknowledges—that private works and companies form quite as effective centres for industrial mobilisation and training as do the State establishments, and it has proved also that they constitute quite as important an asset to the nation.

A further argument in the paper is to the effect that the existence of State establishments tends to regulate and lower the prices asked by private concerns for given work, their prices, it is contended, having a very natural tendency to rise when State competition ceases to stabilise them. If this has ever obtained it has been a very rare occurrence, and this statement of the author's should be read in conjunction with others in the paper, notably that in which a period of duty in private naval construction works is advocated for members of the staff of State establishments, in order that they may acquire an insight into the economics of their profession, or be able "to develop the economic sense."

In every maritime nation there is room both for State navy yards and for private industrial concerns making one of their specialities the construction of naval and military material. Admitting the former to be maintained well equipped with modern plant for research and for new construction work, they are able to render the nation most valuable service, particularly at the present time when naval aeronautics is becoming an important branch of the Service. Whether a nation could better dispense with its naval dockyards than with an equal number of privately-owned establishments is a very moot question which we need not enter into here. The success which private shipbuilding companies have met with since the Armistice in the construction of types of engines and machinery entirely new to them, such, for instance, as locomotives, compared with the failure of similar attempts by State works, illustrates very clearly the difference in flexibility of the two types of organisation. One French expert has advocated a revision of the account-keeping methods of the State establishments. An improvement may be necessary under this head. Centralisation in the Metropolis of the management of the actual every-day work at the arsenals and dockyards, combined with antiquated routine, is probably the greatest difficulty with which they have to contend. State dockyards will never be able to compete with private yards, in regard to rapid delivery at all events, in peace time, if it takes weeks for a letter from the Ministry to filter through all the gradations of the Service to give permission for the use of a fresh plate in the place of one having developed defects at the time when it was about to be built into the hull of a ship on the stocks. "Administrative automatism with its passive irresponsibility" is a feature the author complains of; it is, we are afraid, very prevalent, and if it could be got rid of, together with the "formidable deadweight of rules and regulations" which hem in all State-owned institutions, these would very readily assume an industrial character, provided they were well maintained with modern machinery and implements.

It is curious to notice that whilst naval architects have been advocating the decentralisation of State-owned establishments—for in the main it is at decentralisation and at obtaining local initiative and responsibility that they are aiming—some private works, on increasing the scope of their specialities, have been working in a reverse direction, and have centralised their whole management, designing departments and drawing offices included, in Paris, or have made serious attempts to do so. In the light of the paper we have commented upon in this article, this would appear to be an entirely wrong conception and one which is not in the least conducive to rapid and economic execution.

THE PHYSICAL AND OPTICAL SOCIETIES EXHIBITION.

(*Concluded from page* 52.)

CONTINUING our description of various exhibits, we may first refer to the mutochrome of the Chromoscope Company, 298, Regent-street, W., the invention of Mr. C. F. Smith, of Messrs. Adam Hilger. This is an ingenious combination of camera and projector used for varying colour combinations in patterns and designs. The instrument consists essentially of a battery of lenses grouped and mounted close together. These lenses photograph the elements of the pattern and throw the picture elements on the photographic plate behind, which is then developed and afterwards reinserted for projection on the screen by the light of a projector lamp inside the camera. The light from this lamp passes through a system of prisms and condenser lenses, through the plate, and through the photographic lenses first mentioned. In front of each of these lenses (that is, further away from the lamp) is an iris diaphragm for varying the light intensity and an exchangeable colour screen; further out still is one enlarging lens for the whole camera which produces the image projected on the screen. There is thus only one plate, each lens projecting its own element of the pattern. In a pattern made up of roses, leaves and a background, the one lens would photograph (and subsequently project) the roses, another the leaves, a third the background, and each partial image would be independently variable as to colour and brightness by changing the colour screens and manipulating the iris diaphragms.

Among other exhibits of Messrs. Adam Hilger, Limited, was the spectro-comparator of Mr. Twyman and Mr. C. F. Smith, an instrument for the convenient comparison of two spectra applied in the form of glass-strip negatives. The apparatus consists of a lamp-case with two condenser systems sending their rays upward through two parallel slots on which the test specimen and the standard are placed. Above them are two projector lenses and inclined mirrors which throw the two spectra on a screen several feet away, on which they appear the one above the other. Another novelty, a new grating spectrograph, was especially designed to order for dark-room use, and the parts therefore do not require a closed case. The instrument may be described as an optical bench which supports the concave grating at the one end and the camera at the other end. The grating is mounted vertically, adjustable in various directions, on a platform attached to a screw running the length of the bench. The camera frame is pivoted to turn in a horizontal plane through measured angles, remaining all the while close to and in the plane of the vertical slit through which the light is admitted. By these means spectra of different orders are brought into view. The camera front is provided with a horizontal slit which can be screwed up and down, so that one photograph after another can be taken on the same plate. The whole bench, which consists of steel girders, can be suspended to avoid vibrations.

The bore-inspection apparatus of Mr. Twyman marks a development of the apparatus shown at Wembley. It is especially designed for examining the internal surfaces of holes bored in forgings of turbo-generators, &c., for the detection of flaws. The lamp-box, with condenser and mirror (perforated in the centre for the eye of the telescope observer), is placed on a tripod in front of the object. A hollow cylindrical frame, bearing at the end a mirror inclined at 45 deg., is pushed into the bore and turned slowly by the observer with the help of a long steel rod, on which a scale is marked. As the mirror turns, different portions of the inner surface of the bore are brought in view, and the tool marks and flaws can be examined and their positions determined.

Last week we omitted to mention a striking novelty of Messrs. C. Baker. This is their rod illuminator for microscopes, a plain rod of a special colourless glass, 0·4 in. in diameter, 1 ft. long, which is drawn and bent to an S-curve, so that when the rod is clamped in a little stand, the one plane end is vertical and the other horizontal. The former end is brought up close to the window of an ordinary 24-c.p. lamp, encased in black; the horizontal end is brought directly under the microscope stage. The field then appears uniformly and brightly illuminated; the rod looks bright, but the light seems to flow through the curved rod like a liquid.

A variety of fine microscopes was exhibited by Messrs. Ogilvy and Co., of 20, Mortimer-street. The microscopes, notably the monobinocular and the metallurgical microscope and camera, are of the Leitz (of Wetzlar) type, as also is the micca micro-camera attachment which will fit the draw tube of any standard microscope. This attachment, for taking photomicrographs of 6 by 4·5 cm., weighs only 6 oz. It looks like a funnel, the photographic slide being on the top and the observer looking through a short side tube, and in some other instruments obliquely downwards. The scaleometer of Messrs. W. Ottway and Co., of Ealing, is a little

novelty, a pocket reading microscope consisting of a Ramsden eyepiece with a scale divided on glass fixed in the focal plane. The instrument is intended mainly for the examination of opaque objects (screw threads, Brinell impressions, &c.), and is therefore fitted with a thin glass plate at 45 deg. between the two lenses to reflect diffused light on to the object.

The Eastman universal colorimeter of Messrs. Kodak, Limited, measures the colours of fabrics, dyes, glasses, decorations, solutions, &c., in terms of visual appearance. The instrument consists of a stand containing a standard lamp and supporting a horizontal telescope tube, 2¼ ft. long, and underneath the tube a board for four sliders for green, blue, red, and neutral grey tints. At the one end of the tube is the eyepiece and near the other end, which faces the specimen to be examined, is the telescope focussing ring. The specimen illuminates half the field of view; the light from the lamp illuminates the other half after passing through gelatin wedges, dyed in the four tints mentioned. The colorimeter operates on the subtractive principle; the wedges are shifted by the sliders until the colours are matched. Various attachments for holding liquids and other samples, for reflection tests, &c., facilitate the use of this very simple instrument. The other novelty of the firm, the ciné-kodak, is a portable kinematograph outfit, weighing 8 lb.. It is more useful than its name is fortunate, and is said to be 80 per cent. cheaper in running cost than other kinematographs. A small electric motor, which can be fed from an ordinary lamp socket, drives two reels carrying 100 ft. of Kodak film, 16 mm. wide, each picture of which is 10 by 7·5 mm.; 1 ft. of the film contains 40 pictures and lasts 2⅓ seconds. The screen of aluminium fabric, 30 by 40 in. for ordinary rooms, fits into a special box, the parts of which make up the screen frame. The whole apparatus can be set to work in a few minutes.

Messrs. James Swift and Son, of 81, Tottenham Court-road, W.1, specialise in microscopes and goniometers. Their universal-technical microscope is of the improved Climax vertical-lever type. They also showed the lapidex microscope for petrologists and the Grabham-Dick microscope, the latter a modification by Mr. G. W. Grabham, geologist to the Sudan Government, of the Dick microscope. The Shand recording micrometer of the firm, due to Professor S. J. Shand, of Stellenbosch, South Africa, is a peculiar device facilitating quantitative estimation of distinct minerals in rocks. The rock section, mounted on a glass slip, is carried by means of a small frame in a rectangular slide, movable to right or left, and itself movable on a second slide; each slide is worked by a separate micrometer screw reading to 0·01 mm. Within the inner of the two slides and actually carrying the glass slip, the small frame slides in a dovetail fitting from front to back. The whole is mounted on a microscope stage, and the device can also be used for estimating the proportions of steel constituents, food adulterants, &c.

The Wray Optical Works, of Bromley Hill, Kent, exhibited their various photographic and other lenses, and a peculiar diffused image objective which, by a special treatment of the glass, gives purposely diffused images, in order to soften the contrasts in portrait photographs; this lens is put in front of the final lenses. Their lumeter is a neat novel modification of the holophane lumeter. The old lumeter was tubular. The new instrument is an aluminium casting covered with vulcanite; it resembles a small camera and fits into a portable case. The lumeter reads direct up to 4-ft. candles and by dark screens up to 4,000-ft. candles. The nephelometer, due to Mr. R. Kingslake, also exhibited by Messrs. Wray, measures the opalescence of solutions and gels by making a match, in the field of view, against a standard solution.

Messrs. Cooke, Troughton and Simms, Limited, exhibited a theodolite fitted with a novel device, due to Mr. E. A. Reeves, for observing stars without cross-wires or field illumination. Two images of the star are seen, the one by direct vision, the other by double reflection; when the star is exactly in the centre of the field, the two images coincide; otherwise they part and move in opposite directions. Thus greater accuracy is secured, and the device should be useful also in mines, where lamps have to be used as sight-marks. The object is attained by means of two small, thin glass discs slightly silvered on one side, so as to transmit and to reflect parts of the light. One of these discs replaces the ordinary diaphragm in the focal plane of the telescope; the other is screwed over the eye lens, where it is adjusted by four capstan-headed screws. The first star image is formed on the silvered face of the diaphragm; the transmitted light passes through the eye-piece and emerges as a parallel beam on the eye-lens reflector; part of this beam is reflected back through the eye-piece and forms a second real image on the silvered face of the diaphragm. This reflection backward and forward is repeated indefinitely, but in a 5-in. theodolite the third and following images are invisible. The device does not in the least interfere with the telescope construction and can be fitted into any theodolite.

The continuous chart recorder, primarily designed for pyrometry work, of the Foster Instrument Company, of Letchworth, which is shown in Fig. 13, is distinguished by an ingenious mechanism for oscillating the inking ribbon with the aid of a system of cams which are out of step, so that two or more records can be produced on the same width of chart. The mechanism comprises an automatic commutator driven synchronously with the ribbon oscillation. The record is made in the usual way by the periodic depression of the galvanometer boom; a series of dots is produced on rectangular co-ordinates, the pressure resulting at a virtual point by the intersection of two knife-edges, the one carried by a boom and the chart travelling over the other. The automatic commutator is provided with a very simple arrangement for cleaning the contacts without dismounting the commutator; this is important for work of high sensitivity, particularly with low-potential thermo-couples. The moving system is carried on jewels and pivots by the use of the "Resilia" mounting of the firm, which we have noticed on other occasions.

The new dead-beat compasses of Messrs. Henry Hughes and Son, Limited, of Fenchurch-street, differ from the one we described on page 54 of January 11, 1924, by their aperiodic motion, which brings the compass back to zero within 11 seconds when deflected 45 deg., the overswing not exceeding 5 deg. This remarkable result is obtained by means of eight fine radial wire filaments, which, while of small inertia, produce high eddy resistances. The 6½-in. card in a 10-in. bowl has two strong magnet-needles of cobalt steel, 2½ in. long. Fitted with a quick-release clip, these Campbell-Bennett compasses are especially designed for aircraft, as well as for navigation.

Messrs. Negretti and Zambra, of 38, Holborn-viaduct, E.C.1, showed several novelties in thermometers. Their aircraft thermometers are of the Bourdon tube type, and are provided with honeycomb guards. The earth thermometers are of interest to miners and farmers as well as to meteorologists. The thermometers for machinery bearings are of the mercury-bulb type and are fitted with an adjustable contact so as to give warning; the device is provided with a cylindrical casing for insertion into the bearing. The Dubilier Condenser Company, of North Acton, had on view a great variety of variable condensers, distinguished by various names, insulators, switches, &c., mainly for radiotelegraphic service.

The chief novelties of Messrs. A. C. Creed and Co., Limited, of Croydon, are their keyboard perforator for punching international Morse, or any of the five-unit codes, and their direct printer. The direct printer, the only machine of its type of British design and manufacture,* is a start-stop printing telegraph, worked either automatically or by means of a punched slip, or from a typewriter keyboard. Worked manually, its printing speed is 70 words per minute, but this figure can be raised automatically to 110 words. The transmitting unit consists of a standard keyboard fitted with a motor-driven distributor and

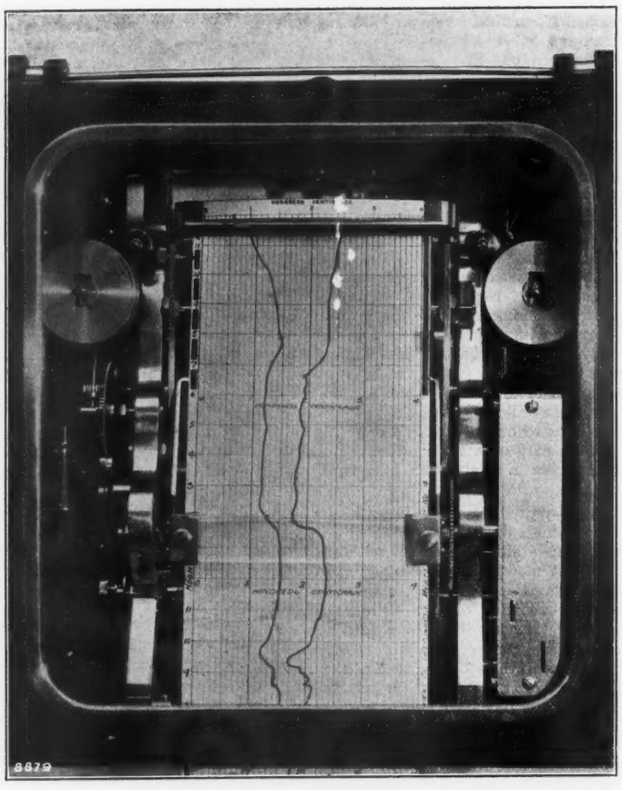


FIG. 13. CHART RECORDER FOR PYROMETRY; FOSTER INSTRUMENT COMPANY.

* Compare "Developments in Printing Telegraphy," ENGINEERING, January 2, page 4 *ante*.

governor. Placed at right angles behind the key bars, and extending the whole width of the board, are five slotted combination bars, the ends of which loosely engage a bank of five contacts, negatively charged when at rest and connected to the distributor. The depression of a key, and consequent engagement of the slotted bars, reverse these contact pieces in the order of the selected permutation. The distributor makes one revolution, and the signal is transmitted to the line by a brush being brought to rest on a negatively-charged stud with each depression. The line signal of seven units (the five-unit, the positive "start" signal, and the negative "stop") is received on an ordinary line relay controlling a power relay. The tongue of the latter relay first starts up the motor, then releases a clutch pawl, or detent, holding the camshaft of the receiving printer in suspension, and further rocks a lever and striking pin (according to the selection) which rests in one of two positions, *i.e.*, to strike and to select with positive units, or to miss and to stand idle with negative units. The striking pin is moved sideways in front of five

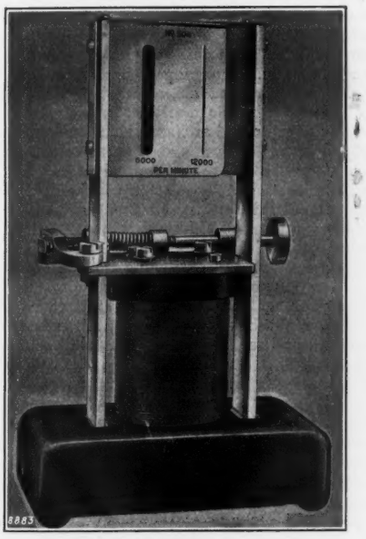


FIG. 14. STROBOSCOPIC VIBRATOR; CROMPTON AND CO., LIMITED.

vertical selectors, striking or missing them as indicated. The struck selectors transmit sufficient radial movement to the six circular combs to cause any one of 50 bell cranks to engage a selected slot, thus stopping the revolving type head and bringing the selected type in front of the platen ready for the impression. The printing can be on slip or in column form.

The two chief exhibits of Messrs. Crompton and Co., Limited, of Chelmsford, involve designs due to Professor David Robertson, of Bristol, and the firm. The Crompton-Robertson bridge potentiometer is intended for educational purposes and, with additions, for use in meter and test rooms. It meets the double purpose of an ordinary four-gap slide-wire bridge and a simple potentiometer, and may also be used for millivolt tests. The essential part of the other exhibit, the Crompton-Robertson stroboscopic vibrator, is the Robertson vibrator, a tuning-fork, consisting of two vertical bars, clamped into a cast-iron base which supports the electromagnet as shown in Fig. 14. The bars are easily replaceable if other frequencies are desired. At its upper end each bar carries a vane, the one in front of the other; the front vane has a wide and a narrow slit, the back vane only a narrow slit. The observer holding the vibrating fork before his eyes, sees by "edge" or by "slit" vision. In the former case, the path is normally closed, except when the displacement is great enough in one direction; in the latter case the two slits are exactly in the line of sight when at rest, but the path is closed when the displacement of each bar is half the slit width. Edge vision gives an opening at each extreme of positive displacement; slit vision gives an opening each time the bars pass their equilibrium position. With edge vision the frequency of the glimpses is the bar frequency, with slit vision twice that frequency. The frequencies selected are 6,000 and 12,000 (or 3,000 and 6,000) per minute, because these figures have a large number of factors which are convenient for speed estimates and their submultiples. The observer may look through the vanes or (more generally) watch the arc beam passing through. The usual stroboscopic discs for "running-down" tests consist of seven concentric rings, with 15, 16, 17, 18, 19, 20 and 80 teeth respectively, and have a diameter of 12 in. Overlapping Gothic teeth are convenient for submultiple speed estimates; a table is needed for the interpretation of the observations. The stroboscope is driven by two storage cells.

The new traction recorder, of Messrs. Evershed and Vignoles, is chiefly interesting because one instrument, gives a complete indication of electric train-running characteristics. The recorder, measuring 20 in. by 20 in. by 8 in. deep, shows side by side on the charts volts, current, speed, train stops, and duration of brake application. One clock mechanism drives two charts mounted on a common spindle; the first three quantities are marked on the left chart, the speed and brake operation on the right. All these records are automatic, with the exception of the train stops and the brake applications, which are operated by switches controlled by observers in the driver's cab. The normal chart feed, 6 in. per minute, by altering the gears without changing the clock mechanism, may be reduced down to $\frac{1}{2}$ in. per minute. To overcome train vibrations, the movements are balanced and oil dash-pots of extremely small surface area are provided; the pen, moreover, rests directly on the chart paper, and in a test run on the District Railway the pen vibrations did not exceed $\frac{1}{32}$ in. on either side. The voltage records and current variations give information about track conditions, bonds, motor control, &c.; the acceleration shown is a guide to the effect of "notching up," manually or by automatic control, while from the speed, current consumption and brake records the economy of running can be estimated.

As in the two previous years, the Edison-Swan Electric Company confined its exhibits to pointolite lamps, with their projectors, ranging from 30 to 4,000 c.p., operating on d.c., and for 150 c.p. operating on a.c. Most of the other electrical firms displayed varieties of instruments. The new portable laboratory wattmeter of Messrs. Elliott Brothers is of the dynamometer type; it has two volt and two current ranges, and the volt coil is provided with a reversing and open current switch so that the current through the volt circuit may be reversed without disconnecting when reading the instrument backward. The Rayworth differential cell-testing voltmeter is provided with a differential winding and a cadmium test electrode which, when dipped into the electrolyte next to the suspected accumulator plate, gives a reading of the deviation from the normal potential. When the positive and negative terminals of the instrument are connected to the positive and negative plates respectively, and the cadmium electrode is joined to the centre terminal, the instrument indicates the fraction of the charge remaining available for use.

The measuring instruments of Messrs. Everett, Edgcumbe and Co., Limited, ranged from "dwarf" patterns of 2½-in., for radio service, up to a 300,000-volt electrostatic Kelvin voltmeter, operated by the attraction of fixed and movable elements and fitted with hemispherical guard plates, 14 in. in diameter. The radio-frequency instruments of the firm are made for all frequencies, operating either on the hot-wire or thermo-junction principles. With the former a new condenser (consisting of two concentric tubes) is used, and in the latter a "dwarf" moving coil. The self-contained "cube" integrating photometer of the firm is not exactly a cube, but is a cube with the corners cut off obliquely and painted inside with zinc white. In the shielded radio-frequency transformers, the primary conductors pass through the laminated iron wire and return symmetrically outside it. The double-ratio box of Messrs. Gambrell Brothers, of Southfields, measures the variations in the small resistances of machines, such as electric railway motors, while under load, by comparison with a standard shunt; from the resistance rise plotted the temperature rise is deduced. Most of the exhibits of the Igranic Electric Company, Limited, were apparatus for radio work. The honeycomb duolateral high-frequency transformer coils are wound "on air" (on supports afterwards withdrawn) and fitted with 4-pin plugs. The Unitune aperiodic fixed coupler for the reception of short waves (of the order of 100 metres) is of the same form of winding. The Igranic-Freshman condensers are small slabs, 1½ in. by ¾ in., of brass and mica. There was also a high-resistance potentiometer for the critical control of grid bias, and a variable grid leak constructed on the same principle.

In the direct-working diaphragm Morse sounder of the India Rubber, Gutta Percha and Telegraph Works Company, the inertia is reduced and the sound intensified by the aid of two electromagnets and pivoted polarised armatures, somewhat as in the Post Office standard relay. The tongue carries a steel head or hammer, which plays between the limbs of a tuning fork, and the blows are transmitted to a metal diaphragm which can be fitted with a horn. The whole makes a very neat instrument for rapid receiving with small currents. The self-contained electrical measuring set of the Silvertown firm is a Wheatstone bridge, designed for convenient and rapid use in the works. The re-designing of the dynamometer wattmeters of Messrs. Nalder Brothers and Thompson, of Dalston, was carried out mainly with the object of making the moving system dead beat and of lighter weight. The moving coil, formerly of copper, is now made of fine aluminium wire and the damping device consists of two very light symmetrical vanes, enclosed in a practically air-tight chamber. The frame supporting the field coil is made of manganin, and the shape reduces eddy currents to a minimum. The sub-standard instruments are fitted with knife-edge pointers and mirror scales. Similar improvements have been introduced into the deflectional frequency meters and the graphic frequency meters which record frequency directly. The overload relay due to Mr. C. L. Lipman, of the firm, was described last year. The change-coil, volt-ammeter set of the Record Electrical Company contains two iron movements arranged at each end of the case which, complete in itself, weighs 11 lb. On the current side, the range is varied, from 0·1 to 600 amperes, by changing the six series coils which are slipped over the moving-iron element; each range has a separate scale marked on a drum, which is rotated by depressing a knob. The Weston Electrical Instrument Company of Great Saffron-hill, E.C., drew attention to their new line of Weston a.c. switchboard instruments of various types, fitted with rectangular cases which take up little space. A novelty shown by the Zenith Manufacturing Company, of Villiers-road, N.W., was the Zenite resistance units, consisting of porcelain tubes wound with wire embedded in enamel and now fitted with caps and clips.

Messrs. H. Tinsley and Co., of South Norwood, exhibited several interesting developments of precision instruments previously mentioned, among them being the co-ordinate alternating-current potentiometer of Mr. D. C. Gall, a partner in the firm (see page 57, January 11, 1924), the Tinsley vernier potentiometers, and the phonic motors of Dr. A. B. Wood (January 12, 1923, page 36). The new phonic controllers for maintaining synchronism between an alternator and a fork (itself of novel design), or between two alternators, comprise two phonic motors, each driving a worm and geared with the rheostat controller. In the improved Drysdale slip stroboscope, a phonic motor, displacing clockwork, drives a hardened-steel tape drum on which a small steel roller runs. Electrical contacts have been added to this roller, so that the electric circuits can be interrupted at 20 per cent. above and below synchronism with the phonic

motor. One of the noteworthy features of the three very delicate types of the K. C. Cox relays for automatic signal transmission, to be used in connection with selenium magnifiers, is the device for correcting "bias" of the relay, by means of an oscillating fork of platinum wires. Messrs. Tinsley also manufacture the A. B. Wood cathode-ray oscillograph, recently described to the Physical Society.

The most powerful X-ray apparatus exhibited by Messrs. W. Watson and Sons, was a water-cooled Coolidge tube, 8 in. in diameter and 40 in. total length, giving 50 milli-amperes at 250,000 volts. The target is of tungsten and the leads are of copper (in uncooled tubes, molybdenum stem and leads would be preferred). The Victor C.D.X. X-ray unit of the firm is directly connected with the high-tension transformer, and both are immersed in oil in an earthed 9-in. by 7-in. by 7-in. container, so that danger of shocks from external leads is eliminated. The oscillatory X-ray diaphragm (a grid of vertical lead strips to keep out all but vertical X-rays), due to H. Bucky, of Berlin, and H. F. Potter, of Chicago, was described last year (January 11, page 54). The grid and driving mechanism are contained in a rectangular case, 30 in. by 24 in., the upper surface of which is slightly curved (like the grid), to afford a convenient rest for the patient. The new Hall tungsten lamp of the firm, for ultra-violet radiation, is an arc with two horizontal tungsten electrodes, $\frac{1}{16}$ in. in diameter, which, with currents of 5 amperes, burn away at the rate of an inch per hour. The new selenium density meter for X-ray photometry, which was demonstrated, is a complicated apparatus, but is said to admit of great accuracy; the selenium cell is alternately illuminated by a standard beam and by the beam under test.

THE LATE SIR WILLIAM E. GARSTIN.

THE regretted death of Sir William Edward Garstin, which occurred at his residence in Wigmore-street, London, on Thursday, January 8, three weeks before his seventy-sixth birthday, removed one of the great administrators and pioneers who undertook the regeneration of Egypt, and who by the use of their foresight prepared the way for the prosperity which in recent years has favoured that country. Lord Cromer once said of Egypt that its greatest necessities were justice and water. In the administration of justice our race has always been to the fore, and it is largely due to this characteristic that our success as colonisers has been won. But in the application of technical skill to the finding of solutions to the unusual problems encountered in the development of new territories British engineers have been equally noted. In this sphere the name of Garstin will always be held in the highest respect, not only by men engaged in the same class of work, who can appreciate the nature of the difficulties which were overcome by him and his staff, but also by the landowners and the poorest of the fellaheen in the country which the work benefitted. By his efforts Egyptian territories were made capable of cultivation and became a source of great wealth. The work of the administrator is not always appreciated by the people whom he does his best to serve, for those who are not so far sighted cannot gauge the true significance of the steps taken. In this respect the men concerned with the solution of engineering problems, whether they be connected with transport, power production or irrigation are in a different position, for there is permanent evidence of the good work they have done available for all to see. It is, therefore, not surprising that when Sir William Garstin resigned from his post as Adviser to the Ministry of Public Works in 1908, and made a farewell tour of the parts of the country where his greatest work was done, the strongest of the nationalists vied with loyalists and Europeans in their tributes of gratitude and respect.

Sir William was born in India where his father, Mr. Charles Garstin, was in the Bengal Civil Service, while his mother was the daughter of Mr. W. Mackenzie of the old "John Company." For his education he was sent to England, and after receiving his early instruction at Cheltenham College, he became a student of King's College, London, and at the age of 23 years joined the Indian Public Works Department. After thirteen years' service he was sent to Egypt in 1885, for irrigation work on the Nile, but not until seven years later did he resign his association with the Indian Public Works Department. This he did on taking up the post of Inspector General of Irrigation in Egypt.

The ancient system of basin irrigation was generally pursued in Egypt with the exception of the area acquired by the Khedive Ismail, in the provinces of Asyut, Minya, Beni-Suef, and the Faiyum, for which the Ibrahimia Canal was constructed. This took water out of the Nile on the left bank at the town of Asyut and flowed parallel with the river for 200 miles, and had a branch to the Faiyum. As there was no weir across the Nile at the head of the canal, the water in it rose and fell with the Nile, and was apt to run short during the hottest months. Dredging operations had to be carried on continuously to ensure the provision of the irrigation supply at times of low water. These difficulties were overcome by the construction of a weir across the Nile to give control over the river, and to raise the level of the water over 8 ft. This Asyut weir is about $\frac{1}{2}$ mile long, and is composed of 111 arches, each of 15 ft. span, with piers of 6 ft. thickness. In each archway two gates are provided, and a lock, 240 ft. in length and 48 ft. wide, is available at the western end. The work was started in 1898, and was finished early in 1902, when Sir William Garstin was granted the G.C.M.G., having been made C.M.G. in 1894 and K.C.M.G. in 1897. The Asyut scheme was intended to control the distribution of the supply of water, but in no way to store that supply.

The next important step was the great enterprise of impounding the superfluous flood discharge of the Nile, and making it available for the service of irrigation. The development was a natural one, for the British engineers first saw that full use was made of all the available water at their command and only then embarked on the costly schemes for future developments. When it became evident, through the shortage of water in the hot seasons, that the volume of the river needed to be increased, a site was selected for the construction of a dam above Aswan. The story of the construction of this great dam is of course well known. The greatest work of its kind in the world at the time, the dam has a length of $1\frac{1}{4}$ miles, and is a single straight masonry wall pierced with 140 under-sluices, each of over 100 sq. ft. area, and by 40 upper sluices of over 60 sq. ft. The maximum head of water obtained by its use is $65\frac{1}{2}$ ft. This great achievement is a permanent memorial to the work of Sir William Garstin, to whose requirements as Under-Secretary of State for Public Works the designs and specifications were prepared by Mr. W. J. Wilson, the Director General of Reservoirs, in consultation with Sir Benjamin Baker. Sir William Garstin throughout this work, as was the case during the whole of his career in Egypt, won the wholehearted respect and appreciation of the staff who worked under him, and also of the contractors, Messrs. John Aird and Co., and their resident engineer, the late Sir Maurice FitzMaurice. The Zifta Barrage followed and the Aswan Dam was raised to add further to the facilities for irrigation, while Sir William was in Office in Egypt, the Esneh Barrage following a little later. These works, with the reconstruction of the Calioub Barrage, virtually completed the programme of major undertakings planned to enable the country to be converted from basin to perennial irrigation.

The two main achievements—the Asyut weir and the Aswan dam—were the most important works of Sir William Garstin's regime, but it should also be remembered that thanks to his efforts between 1900 and 1904 the White Nile was cleared of sudd, and freedom of navigation established between Khartoum and Gondokoro. In 1908 he resigned his post of Adviser to the Ministry of Public Works in Egypt, to which he was appointed in 1904, but still retained associations with the country as he became a director of the Suez Canal, representing the British Government. Prior to leaving Egypt he received a remarkable address of appreciation from the many people who understood the value of his work to the country, and it should also be noted that he had, in 1905, been awarded a grant of 15,000*l.* by the Egyptian Government for valuable services. He received the Legion of Honour and the Grand Cordon of the Medjidieh and Osmanieh Orders. During the period of the European War, Sir William took a large part in Red Cross work, and in 1918 he was created G.B.E. Apart from his professional work he was a man of many interests, in which he showed great political, administrative, and financial abilities, and was associated with many of the leading learned societies.

NOTES.

CANADIAN WIRELESS BEAM STATIONS.

IN connection with the development of the Marconi beam system of wireless communication over long distances by means of short waves focussed in the desired direction by specially designed aerials, it may be of interest to mention that a group of new stations is now being erected near Montreal for direct working, on this system, between England and Australia. The transmitting stations are being built at Drummondville, some 40 or 50 miles east of Montreal, while the corresponding receiving stations are located at Yamachiche, which is about 25 miles north of Drummondville, although, roughly, the same distance from Montreal as are the transmitting stations. The latter will be operated by remote control from the Montreal offices of Messrs. Marconi's Wireless Telegraph Company of Canada, who have the installation work in hand. The transmitting aerial for communication with England will be supported on five masts of steel-lattice construction, 300 ft. in height and spaced 650 ft. apart, while for supporting the transmitting aerial to be used for working to Australia only three masts, 250 ft. in height, will be used. The total power requirement for each transmitting beam will be 150 h.p. and will be obtained from the local supply; about 20 kw. of energy will be delivered to the valve anodes for each beam. The Canadian beam station, we understand, is being erected in accordance with an agreement made with the Postmaster-General in July last, to the effect that the Canadian Marconi Company should construct a beam station in Canada for communication with stations to be erected in this country by Messrs. Marconi's Wireless Telegraph Company, Limited, as contractors to the British Post Office. It is provided in this agreement that the sending and receiving stations are to be capable of working simultaneously, and that the aerial systems of the transmitting stations should be designed so as to concentrate the waves within an angle of 30 deg.; a similar type of aerial is to be used at the receiving stations to focus the waves received. Both transmitting and receiving stations in this country are to be capable of operation from the Central Telegraph Office in London by remote control. A working speed of 100 five-letter words per minute in both directions for an average period of 18 hours daily, has been provided for. Traffic rates have not yet been fixed, but, as indicated by Senator G. Marconi in his recent communications to the Royal Society of Arts, to which references will be found on pages 17 and 836 of our last volume, they will probably be materially lower than those at present current.

THE ANALYSIS OF SPECTRA.

In a lecture (one of a course of three) delivered at the Royal Institution on Tuesday afternoon last Professor A. Fowler, F.R.S., described recent progress made in the elucidation of spectra. Many of these are very complicated—that of iron contains hundreds of lines—and the problem of discovering what was the underlying regularity governing the distribution of these lines would probably have proved hopeless had not the key to its solution been found in the study of simpler spectra. Of these, the simplest is that of hydrogen, and Balmer showed in 1895 that the lines then recognised

were all included in a formula which, when expressed in terms of the wave-number ν, could be written as

$$\nu = 274118{\cdot}75 - \frac{109675}{m^2}.$$

Here ν is the reciprocal of the wave-length in cm., and is preferred to the latter, in specifying a line, because the energy required to generate this line is directly proportional to this wave-number. If, in the above formula, m be given successive integral values starting from 3, then lines are found corresponding to all these values of m. By this formula the existence of certain lines in the ultra-violet could be predicted, and these were subsequently discovered. Later on Lyman found another series of lines in the ultra-violet which were all included in a formula of an exactly similar type, viz. :—

$$\nu = 109675 - \frac{109675}{m^2},$$

where m takes in succession all integral values starting with $m = 2$. Later still Paschen found a series in the infra-red which followed an exactly similar law. The characteristic feature of all these formulas is that as the value of m increases, the lines get closer and closer together, and tend at the limit to the value of the first term. It may be added that this limit of one series is commonly also represented by a line in a totally different series. Formulas of a similar type were found to apply to more complicated spectra, and it was thus possible to sort out lines tending to the same limit. In certain cases two or more series of lines tended actually to the same limit, and we thus get doublets such as the well-known D line in sodium. All metals of the alkaline group have spectra characterised by such series of doublets, the spacing between which increases in proportion to the square of the atomic weight of the element under examination, whilst in the third group of the chemical elements series of triplets are found. It was at one time thought that in the fourth group of chemical elements we got back to doublets again, but Professor Fowler stated that it had more recently been found on closer inspection that the components of these doublets were or might be themselves doublets, and the complication increased as we progressed from one group of chemical elements to the next higher in order. Professor Fowler further stated that, guided by this hint, Señor Catalán, working in the speaker's laboratory on the spectrum of manganese, had in 1922 recognised groups of diffused triplets of which each member was itself multiple, being, in fact, a triplet. Since then series of multiplets had been detected, of which each member consisted of 15 lines. Each of these multiplets, it should be remembered, is a unit in the same sense as the D line of the sodium spectrum is a unit. The work of analysing the spectra and detecting the groups had, Professor Fowler said, been greatly forwarded by the use of certain empirical rules based on quantum considerations which had been formulated by Sommerfeld.

SS. "PALLAS" TRIALS.—The oil tank vessel ss. Pallas, built by Messrs. Ateliere and Chantiers de Sud Ouest at Bordeaux, for the Compagnie Auxiliaire de Navigation, under the supervision of Messrs. Flannery, Baggallay and Johnson, Limited, consulting engineers, of Fenchurch-street, London, was recently taken for trial at sea when a mean speed of 10¼ knots was attained on the measured mile. The vessel is 390 ft. in length between perpendiculars, 53 ft. in breadth and 31 ft. in depth, and is constructed to carry about 8,000 tons deadweight, with a draught of 24½ ft. The propelling machinery consists of a set of triple-expansion engines constructed by Messrs. John G. Kincaid and Co., Limited, of Greenock, the cylinders having diameters of 27 in., 44 in. and 73 in., while the stroke is 48 in. Steam is supplied by three boilers, each of which has a diameter of 15½ ft. and a length of 11½ ft. These boilers have a working pressure of 180 lb. per square inch and are fitted with forced draught. White's low-pressure oil-burning installation has been adopted. Eight main cargo tanks have been provided, and also four summer tanks at each side of the ship. The bunkers can carry coal as well as liquid fuel and, in addition, a large deep tank for either liquid fuel or ballast is supplied forward. Transfer and large cargo pumps are mounted on the deck in addition to the usual auxiliary machinery. The entire vessel was built in accordance with the requirements of the Bureau Veritas, in accordance with the French law and for Lloyd's highest classification.

GEAR TESTS AT THE NATIONAL PHYSICAL LABORATORY.

MESSRS. SULZER BROS., of 31, Bedford-square, London, W.C. 1, and of Winterthur, Switzerland, recently sent for test to the National Physical Laboratory a "Maag" spur wheel. From the report on the results of the test we note that the spacing and pitch errors of both sets of tooth faces were measured, as also was the error in the form of the profile. The circular pitch error in no case exceeded $\frac{2}{10,000}$ of an inch, and in about two-thirds of the cases was less than $\frac{1}{10,000}$ in. The eccentricity error also did not exceed the latter limit. The report states that "as regards the location of the teeth this gear reaches a high degree of precision in all respects." The errors in the form of the profile in no case exceeded $\frac{1}{10,000}$ in., and, in fact, the report states that these errors in form were comparable with the possible errors of observation. The error in parallelism between the axis of a tooth and the axis of the wheel was found to be less than $\frac{1}{10,000}$ in. in the full length of the tooth.

Messrs. Sulzer suggest that in view of the high accuracy thus proved to be attained in the manufacture of these gears, it would be well if the delicacy of the testing instruments could be increased. The teeth of these gears are finished by grinding, the operation being effected by two saucer-shaped discs which grind on the edge only. The actual cutting surface lies, therefore, wholly in a plane, and thus a true involute form must be given to the tooth, if the proper relative motion is given to the gear operated on. To compensate for wear a device is fitted which acts every few seconds, and ensures that the proper relative position of the disc is never in error by more than $\frac{1}{1,000}$ mm. It is thus possible to grind gears of any face width, and Messrs. Sulzer have already supplied these ground gears with a face width of 900 mm. (35·44 in.)

YEAR-BOOKS AND ANNUALS.

The Motor Ship Reference Book.—A valuable addition to the few books that are always kept at hand by an engineer has been made by the publishing of the Motor Ship Reference Book for 1925. This is an entirely new work for the compiling of which the staff of *The Motor Ship* was responsible. It is an exceedingly useful volume for all who are concerned with motor ships or shipping. Practically every type of modern Diesel engine is referred to in the book and illustrations are used freely to supplement the information given in the very concise but adequate descriptions. The dimensions of every motor ship, afloat or under construction, are given in tabular form, with a statement of the power of the engines and their type. Statistics relating to the tonnage of motor ships constructed at various periods are provided, and show that in the quarter ending September, 1924, there was more motor ship tonnage under construction than steam tonnage. Chapters on auxiliary machinery for motor ships and on fuel oil, add to the usefulness of a very serviceable reference book, which is published by the Temple Press, Limited, 7-15, Rosebery-avenue, London, E.C.1, at a price of 5*s.* net.

Ice and Cold Storage Trades Directory, 1925.—The fact that some seventy new companies proposing to engage in refrigeration were registered during the year ended August, 1924, indicates the rapidity with which this already extensive industry is growing throughout the country. Due to this development and the peculiar nature of the operations involved in the mechanical production of cold, the task of compiling a compact year book of value to all of those engaged in the trade is a difficult one. The eighteenth annual issue of the "Ice and Cold Storage Trades Directory, 1925," just published by Messrs. Iliffe and Sons, Limited, of Dorset House, Tudor-street, London, E.C.4, at a price of 10*s.* 6*d.* net constitutes an informative work of assistance to both technical and commercial men associated with this class of occupation. The first fifty pages of the volume contain a collection of tables on temperatures at which to keep different produce, heat insulating materials, specific heats and melting points of substances, the properties of steam at different pressures, pipe flow properties of calcium and sodium chloride brines, with information on freezing mixtures, data on tanks used for ice making, on the properties of various solutions and on several different saturated vapours. A list of cold stores and ice factories in the United Kingdom follows, arranged alphabetically according to locality, while a directory giving the names of persons connected with the trade is provided. A further alphabetically classified occupational directory is included in the volume which increases its value as a work of reference.

The South American Handbook, 1925.—To the manufacturing trader and many other classes of the community, it is essential that exact information on transport facilities, industries and possible requirements of the countries they are interested in, may be available. Should this be procurable in a concise form in a volume of small size so much the better, and for that reason we desire to call attention to the South American Handbook, 1925, published by South American Publications, Limited, Atlantic House, Moorgate-street, London, E.C.2, at a price of 7*s.* 6*d.* This volume forms a reliable guide to the countries and resources of Latin-America, including South and Central America, Mexico, and Cuba. The information it contains will prove of service to the traveller, whether commercial or not, to the investor desiring information on the various countries, and to the stay-at-home business man, who seeks enlightenment on matters which are not dealt with concisely in other publications. In the 1925 edition the local information concerning the cities, districts and other territorial divisions has been greatly increased, and the steamship services and rail routes are dealt with clearly. The products of South America, in addition to the many references which are given in the sections devoted to the individual countries, are dealt with in a long separate chapter, while the processes they are subjected to in manufacture or preparation for the market are clearly described, and in some cases, information is also provided on the yields and costs.

Annuaire, 1925, *Bureau des Longitudes.*—The Paris Bureau des Longitudes was appointed by the French Government in June, 1795, with a view to carry out improvements in the various branches of astronomy and other sciences. Independent from the proceedings which record the work of its French and foreign corresponding members, it has regularly issued a year book since 1796. The one for the present year has now reached us. It appears in its usual form, measures 5¾ in. by 4 in., and contains close upon 900 pages. It opens with astronomical information and tables, followed by data on physics, meteorology, and special chapters on allied questions. Other chapters and tables give the definitions and values of the whole series of French measurements, the comparison of French units with foreign ones, and deal with tonnage, displacement and other nautical measurements. Very complete figures are contained in the book on the height of mountains, lake levels and areas, depth of oceans and seas, length of rivers, population of countries and towns, &c., arranged alphabetically, and for the various parts of the world. The areas, populations and densities of population of all countries are also arranged in tabular form, separate chapters and tables covering France and Paris. The present edition has two scientific articles of great interest. One is on "The Influence upon the Tides of the Earth's Rotation." The other deals with "Thermionic Valves and their Application to Astronomy," and concerns their use for recording the instant at which stars of low brilliancy pass across the reticule wires of a telescope, for star photometry, recording, &c.; this article is illustrated with numerous diagrams. The book is carefully indexed and its range of usefulness is a very wide one. It is published at the price of 6.50 francs by Messrs. Gauthier-Villars and Co., Paris.

Diaries, &c.—We have received from Messrs. Knight, Frank and Rutley, of 20, Hanover-square, London, W.1, which contains, amongst other general information, several tables, including one useful in connection with timber measurement while a large clear figure calendar and an office clothes brush have been sent to us by the Reason Manufacturing Company, Limited, electrical and mechanical engineers, of Lewes-road, Brighton.

THE REMUNERATION OF TECHNICAL MEN.—Under this heading we published in our issue of December 26 a letter from Mr. Richard Hazleton, the Secretary of the Society of Technical Engineers, commenting on an advertisement in connection with a vacancy for a young engineer at the Royal Aircraft Establishment, Farnborough. The salary offered in connection with the post was 3*l.* per week, with the addition of Civil Service bonus. On December 31, Mr. H. G. Williams asked a question on the subject in the House of Commons and invited the Secretary of State for Air to reconsider the terms. This the Secretary thought unnecessary, as the post was that of a test assistant, not an assistant engineer, as had been suggested, and the salary offered was a commencing one, which would be augmented when the man appointed showed his worth. The Society of Technical Engineers, in their comments on the answer, stated that it shows the salary suggested is offered only to very junior men, while the advertisement indicated that a good technical training and many years of practical experience were expected from the candidates.

LABOUR NOTES.

SPEAKING at Darwen the other night, Mr. Clynes said that better production did not necessarily involve harder work. It involved new methods, more skilful sub-division, and the acceptance of any agency which would assist in increasing profits without increasing the price. If workmen could be assured that they would share in the better results, and if they could see that, so far as there was to be sacrifice and service for the restoration of trade, such sacrifice and service would be fairly shared by all, they would shirk no duty or obligation which properly they should face.

Considering that the engineering trade unions declined to discuss the question of stability with the Engineering and Allied Employers' National Federation until their unreasonable demand for an increase of wages—unreasonable, certainly, in the light of Sir Allan Smith's figures—was satisfactorily disposed of, the willingness of the workers to forego anything in order to bring about a restoration of trade is not very apparent. Nor are the engineering trade unions the only organisations of the kind which are, at the moment, to the fore with demands for increased wages which the industries employing their members obviously cannot pay. The shipbuilding trade unions are also pressing for additions which the plain facts of the matter prove to be economically impossible, and the restoration of industry appears to be the very last thing in the minds of their members. Practically every other important group of organised workers is showing, to be quite candid, the same absolute disregard of the parlous economic state of industry, and nobody ought to be better aware of this really than Mr. Clynes.

His declaration, that better production involves "new methods, more skilful sub-division, and the acceptance of any agency which would assist in increasing profit without increasing the price," ought to be broadcast for the benefit of thousands of workers who clearly think otherwise. The objector to piece-work has views in this connection which, if Mr. Clynes is right, call for revision. The manipulator of the oxy-acetylene burner in shipbuilding, and certain other of his fellows, clearly need enlightenment on the subject of agencies which assist in increasing profit without increasing price. Some of the members of Mr. Clynes's own union have opinions on the machine question, which are, no doubt, similar to his own, but very different from those of the fully skilled mechanic. Moreover, almost every skilled trade has demarcation rules the effect of which is to make the cost of labour much dearer and the speed of production a great deal slower than ought to be the case in well-regulated industry.

The idea of linking up the various Trades Councils of the country with the General Council of the Trades Union Congress is to be advanced a further stage. Another meeting of the Consultative Committee, which was appointed some time ago, is to take place in London early in March. At this a number of questions, including the charter adopted at Hull, and the amalgamation of trade unions, will be discussed. Subsequently, conferences are to be held in about twenty districts for the purpose of considering questions remitted to them by the London conference. Members of the General Council will attend these meetings and also take part in demonstrations arranged by the local bodies. The experiment is interesting from several points of view, and trade unionists generally are hopeful that it will succeed.

On behalf of the Labour Co-partnership Association, Colonel J. H. Boreston, Mr. Cuthbert Plaistow, and Mr. E. W. Mundy gave evidence at a recent meeting of the Committee on Industry and Trade. The witnesses submitted that one of the main causes of industrial unrest was a feeling among workers that they were not getting an adequate share of the production on which their labour was expended. The Association, it was explained, advocated that all workers should share to some extent in the profits, capital and control of businesses in which they were employed. They should be allowed to accumulate their shares of profit in the capital of the business, with the result that they would obtain a share of the control (*a*) by acquiring share capital, and consequently the rights of shareholders, and (*b*) by the formation of co-partnership committees of workers having a voice in the internal management of businesses. Mr. T. C. Taylor, of Messrs. J. T. and J. Taylor of Batley, Mr. E. J. Burrow, of Messrs. E. J. Burrow and Co. of Cheltenham, Mr. Foster Robinson, of Messrs. E. S. and A. Robinson of Bristol, and Mr. W. Wallace were present, and gave the committee full details of the schemes in operation in their businesses.

The executive council of the Amalgamated Engineering Union has informed branches of the organisation that they must have nothing to do with the National Minority Movement's "Unity" conference in London on January 25. This is, of course, in line with the policy which, as we stated a week or two ago, has been followed for a considerable time. One or two of the district committees—amongst them the London District Committee—wished to affiliate locally with the National Minority Movement, but the executive prohibited them from doing so. The position of the organisation is again clearly stated in the latest warning which has been issued to branches. "The Executive Council," it is stated, "wish to emphasise the fact that our union has been built up on a democratic basis, viz., by majority rule and, therefore, it must be distinctly understood that no member can officially attend the Minority Conference and speak in the name of the A.E.U.: further, the funds of the union cannot be used nor any levies raised and charged upon members' cards for the purpose of paying delegation or any other expenses in connection with this Conference."

A wages reference by the trade union side of the Shipbuilding Trade Joint Council for Government Departments was heard by the Industrial Court on January 11. An advance of 6*s.* 6*d.* per week was claimed for fitters, turners, pattern-makers, blacksmiths, shipwrights, boilermakers, ironfounders, coppersmiths, electrical fitters, joiners, masons, painters and plumbers employed in the Royal Dockyards and other Admiralty establishments, on the grounds that such an increase was necessary in order to raise craftsmen's wages to a proper standard in relation to those paid to semi-skilled and unskilled workers. It was stated that the estimated cost of the increase would be about 350,000*l.* per annum. The Court intimated that it would issue its decision in due course.

The average worker will not find it easy, we imagine, to be as concerned about the Supplementary Reserve Army Order as Mr. Cramp and Mr. Bromley have permitted themselves to be. The difference between the Order itself, and the explanatory letter sent out by the railway companies on the point of the liability of the men to be called to the aid of the civil authority is unfortunate, as it gives extremists an opportunity to suggest that something more is really intended than appears on the surface. Apart, however, from the knowledge that the continuance at work of even the full number of railwaymen reservists would have an inappreciable effect in the event of a strike of railwaymen, the ordinary worker—who is not an out-and-out Communist—has good reasons for declining to be excited over the matter. The civil power, he realises, can only need the aid of military—in this sense—transport when the community is in some sort of danger—from, for example, foreign enemies or internal disorders, or attempts to hold up its ordinary activities, or, its food; and in these circumstances he, naturally enough, believes it to be the duty of all citizens, whatever their calling or their political opinions; to go to its aid. There are, of course, men in the movement, some of them high up in it, who believe otherwise; who, as a matter of fact, regard it sound tactics to make the public suffer in order to achieve their ends. But the majority of the rank and file think otherwise, and even a section of the minority inclines to the view that while it is not improper to make the public suffer it may be inexpedient to do so. Labour, they argue, is already exposed to critical fire from so many quarters that it is, in their opinion, a pity needlessly to multiply the number.

The suggestion of one of the Scottish building trades employers, that a joint conference of representatives of all the interests involved, including Lord Weir, should be held for the purpose of discussing the conditions under which steel houses should be built is, it seems to us, worthy of serious consideration. The position, as it stands between the building trades unions and Lord Weir, appears to be simple enough. Mr. Coppock says that his organisation is not prepared to permit any person to interpose a condition of labour over the heads of those who are regarded by both sides as the negotiators. "We have no objection," he declares, "to steel houses as such. You can build houses of steel, paper, or any other substance that can be so utilised, but in all these cases the bulk of the material used is what we know as builders' materials—glass, window frames, doors, interior joinery, fittings, and such like—and we are not prepared to allow anyone to use those materials unless they observe our conditions and pay our rates of wages. Lord Weir is attempting to super-impose upon the industry conditions of employment that are entirely foreign to it—conditions which have never been negotiated upon between the employers and ourselves." Such an attitude, betrays, of course, a striking lack of sympathy with the plea of Mr. Clynes for the consideration of new methods of production, calculated to facilitate the recovery of British industry. Obviously, however, it derives no little strength from the fact that the conditions which are insisted on have been mutually framed by the building trades unions and the building trades employers.

The trouble is that Lord Weir's case appears to be just as strong. "We are faced," he says, "with a genuine emergency, and it can only be met by emergency methods. During the war we had experience on a large scale of obtaining all sorts of things by emergency methods, and one of the main lessons we learned was this: We found that it did not matter how complex or how elaborate the article might be—whether a rifle, a field gun, an aero engine, or an aeroplane—if it was really required on a large enough scale, then we could afford to lay out special methods of production, and so sub-divide and simplify the processes that any man or woman, however unskilled, could carry out the production efficiently and economically. Based on this experience, the Weir house has been designed and will be produced." Lord Weir declares, it will be observed, that "the Weir house . . . will be produced," and Mr. Coppock, in effect, that Lord Weir will not be permitted to produce it. The result may therefore, very likely be unprofitable and is likely to involve trouble by transforming the controversy into one of local and Imperial politics. From the point of view of industry that would be, in our opinion, a misfortune. Such a joint conference as has been proposed is, we think, greatly to be preferred.

A Moscow correspondent of the *Soviet Union Review*—which was, until lately, *Russian Information and Review*—states that all the leading economic organisations, as well as the members, are alive to the necessity of making further progress in raising the level of industrial production. Very valuable work is being done in this direction by the Permanent Council for Increasing the Productivity of Labour, an institution about which there has been little information in the foreign press. The Council has just begun an inquiry, the results of which will be worked up by the Central Statistical Department. The object of the inquiry is to investigate the factors limiting the productive level of a given industrial enterprise. One of the Moscow papers, without waiting for the official results, has published the information it has obtained from the Statistical Department and from the agents who conducted the inquiry in the provinces. The impression gained from the latter was as follows: The campaign for increased productivity of labour, which has so enthusiastically been taken up by central organs and local councils, had different effects in different parts of the country. The results, far from being confined to the central districts, were particularly shown in the distant regions.

In some branches of industry the intensification of labour produced by accelerated interchange of working means has given very satisfactory results. In other branches, on the contrary, the want of working capital and the delay thus caused in the payment of wages to the workers and staff, as well as the necessity to pay in bonds (not cash) for goods delivered, made it very difficult to raise the productivity of labour. Information from a number of industrial districts, points to the fact that the problem of intensified productivity of labour is closely connected with the problem of general instruction and special training of greater numbers of qualified workers. The U.S.S.R. suffers in this respect from the same shortage of skilled labour as the housing, the textile, and other industries in Great Britain.

The agents of the Department of Statistics state also (according to communications from South-eastern and other districts), that the intensity of production rises in the enterprises which have adopted unrestricted piece-work payment. In other districts (*e.g.*, the cement industry in the south) increase of productivity was due to a strict selection of qualified workers and the dismissal of those unqualified. In the centre, increased productivity was achieved by cutting down staffs and a general redistribution of work (*e.g.*, in the leather industry).

The Ministry of Labour states that the number of unemployed persons on the registers of Employment Exchanges in Great Britain on January 5 was 1,307,800—998,200 men, 37,900 boys, 238,500 women and 33,200 girls. On December 29, 1924, the number was 1,273,885—969,815 men, 35,308 boys, 238,626 women and 30,136 girls—and on January 7, 1924, it was 1,267,675—941,399 men, 40,359 boys, 248,541 women and 37,376 girls.

CANADIAN STANDARD SPECIFICATIONS.—We have received from the Canadian Engineering Standards Association copies of Specifications for Reinforced Concrete Poles, Railway Wire Fencing and Gates, and Eastern Cedar Poles. Each of these three publications is sold at a price of 25 cents net and may be had from the Secretary of the Association, 522-523, Jackson Building, Ottawa, Ontario.

TOOLING METHODS.

AT the Machine Tool and Engineering Exhibition held last September at Olympia, Messrs. Alfred Herbert Limited, of Coventry, had a display, which was actually of much greater interest than a mere assembly of high-class machine tools. As our space was more than fully occupied at the time with descriptions of the many new models of machines to be seen at the exhibition, it was impossible for us then to deal with this particular feature of Messrs. Alfred Herbert's exhibit, which related more to production methods than to the mechanisms utilised, though, of course, the object was to illustrate the scale of output possible with suitable machines properly tooled. In this exhibit, typical repetition jobs were handled, being put through one or a series of machines in times which are deserving of attention. The machines, for the most part, will be familiar to our readers; the point of interest at the moment lies in the methods adopted and the times achieved.

Fig. 1.

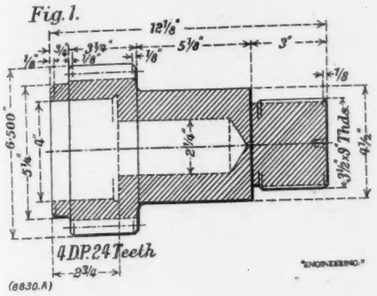


Fig. 3.

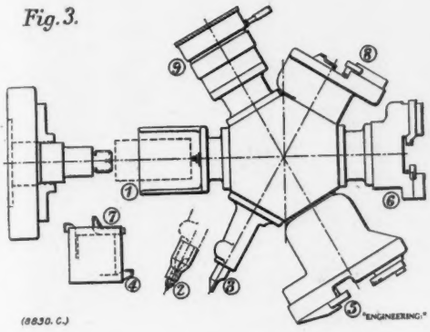


Fig. 4.

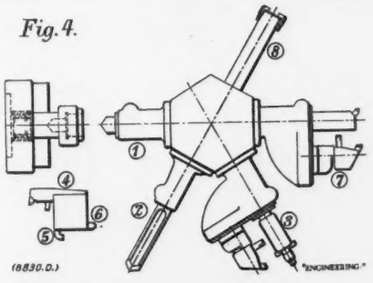
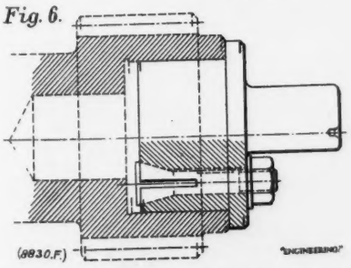


Fig. 6.



The first example we now give is the small pinion illustrated in Fig. 1, machined out of the solid, the gear having 24 teeth of 4 D.P., and with an angle of helix of 25 deg. The bar from which these pinions were made was 6¾ in. in diameter, and of steel of a tensile strength of 35 tons per sq. in. The first operation consisted of cutting off a length of bar on Messrs. Herbert's 6½-in. cold saw. This machine was described in ENGINEERING at the time of the Exhibition of 1920 (See vol. cx, page 341). Although slightly beyond the nominal maximum capacity of this sized machine, the cut was taken in 3½ minutes. The blanks were transferred to a Herbert No. 20 combination turret lathe, having its turret tooled as shown in Figs. 2 and 3. In this lathe a cradle was used at the first turret station to transfer the blanks to the chuck. In subsequent positions of the turret, the end was centred, the diameter was reduced to 3½ in. over a length of 3 in. and to 4½ in. over a length of 5⅛ in., the shoulders and ends were faced, and the smallest diameter screwed to nine threads per inch. The work, after being chucked, was first centred with a removable centre drill (2) Fig. 3, fitted on the centre (3). The jib was then supported on the centre, and the first turning operation was the start made with the tool (4) on the square turret. This gave a start for the large roller-steady box-tool (5), which effected the reduction from 6¾ in. to 4½ in. at one cut at 35 cuts per inch, and 47 revolutions per minute. A feed of 35 cuts per minute was found to be the most economical in view of the durability of the tool, though as coarse a feed as 12 cuts per inch has been satisfactorily taken. Station (6) of the turret is also fitted with a roller-steady box-tool. This reduced the small end from 4½ in. to 3½ in., after which both these diameters were faced by means of the two tools (7) on the square turret, and the groove cut at the back end of the 3½ in. diameter length. A heavy-duty ending tool (8) was then brought into action, cleaning up and chamfering the 3½ in. diameter end. The last operation (9) was performed with a 4½ in. Coventry self-opening die-head at one pass, the 3½ in. diameter length being screwed to nine threads per inch. The whole operation on the No. 20 combination turret took no more than 14 minutes.

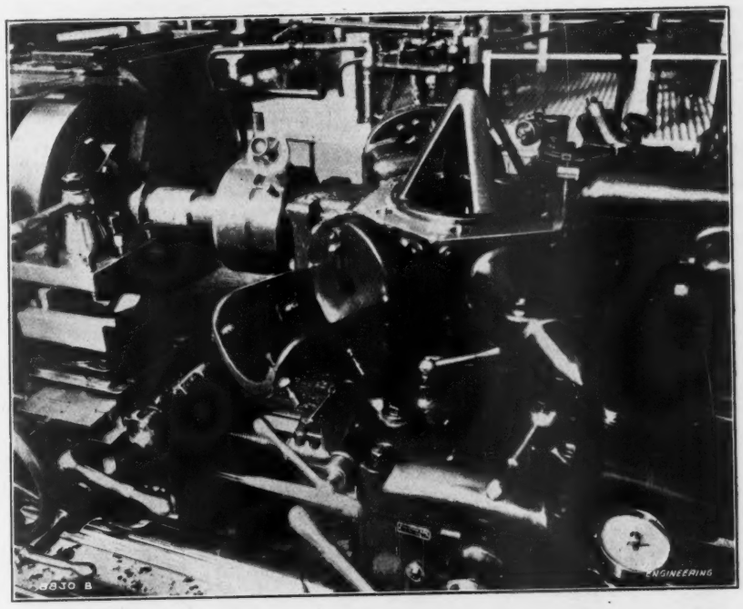


FIG. 2.

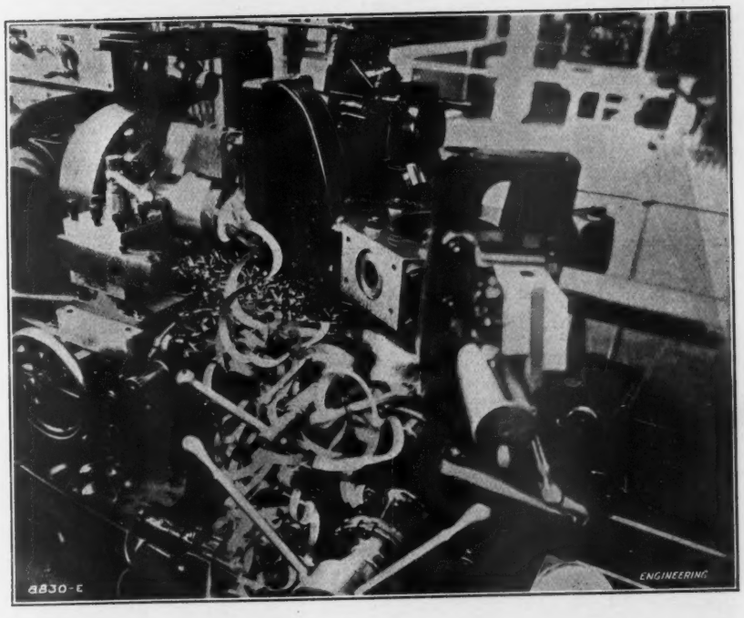


FIG. 5.

Subsequently the work was transferred to a Herbert No. 9 combination turret lathe, being chucked in this by the 4½-in. diameter length. The tooling arrangement of this machine is illustrated in Figs. 4 and 5, and the work included the turning of a 3¼-in. length down to 6½ in., reducing a short end beyond to 5¼ in., facing the end and shoulder, and boring the interior for a length of 2¾ in. to a diameter of 4 in. finished with a reamer, a length beyond this being drilled to 2¼ in. diameter. After chucking, the interior hole was first bored with a straight-fluted drill (2) with inserted spiral cutter. The next operation was a combined one roughing out the 4-in. diameter bore and rough turning the two outside diameters of 5¼ in.

and 6½ in. simultaneously. This was done with the boring bar and knee tool holder (3). The next part of the work was performed with tools mounted in the square turret, the bottom of the 4-in. bore being faced and recessed, and the end of the job being faced, by the two tools (4) simultaneously. Next, the shoulder was faced by the tool (5) and the front and back shoulders of the larger diameter chamfered by the tool (6). A very similar rig (7) to that of (3) was subsequently employed for finish turning the three surfaces rough turned by the combination (3). The last operation on this machine consisted of finishing the 4-in. bore to size with the reamer (8) with projecting floating cutters. The whole cycle on this machine occupied seven minutes only.

The last operation enabled the job to be mounted, as shown in Fig. 6, on a special arbor used in a subsequent operation. On leaving the No. 9 lathe, the work proceeded to one of the firm's No. 16 Universal milling machines, described in ENGINEERING, vol. cxvii, page 491. On this, the 24—4D.P. teeth were cut with a helix angle of 25 deg., this operation occupying 1 hour 25 minutes. The offset reversible arm brace on this machine contributed materially to the rigidity which enabled the rate of output to be satisfactorily attained. The pinion supported on the arbor shown in Fig. 6 was finished on a 10 in. by 50 in. Norton plain grinder.

The next example we shall deal with is illustrated in Figs. 7 and 8. It was a gunmetal cored casting turned outside and partly finished inside with, in addition, 40 teeth cut on the largest diameter, one end screwed, and three holes drilled in bosses on the other end at 120 deg. to each other. The whole piece was finished with the aid of three machines, the first of which was a No. 4 capstan lathe, the tooling of which is shown in Figs. 9 and 10. For chucking, the casting was steadied by the centre (1), after which the combination (2) was brought into action. In this, the boring bar was fitted with three cutters operating on three internal diameters simultaneously, and a chamfering tool for the end of the casting. At the same time, a knee turning fixture holding three tools worked on three external diameters. Simultaneously with this rough turning and boring, a back facing attachment (3), operating through the hollow spindle of the lathe, faced and chamfered the rear end of the casting, which was thus being worked upon by no less than seven tools at once. Another boring and knee turning tool combination (4) was next brought into action for finishing the three internal and three external diameters. With these knee turning tools, an overhead support

Fig. 7.

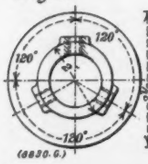


Fig. 8.

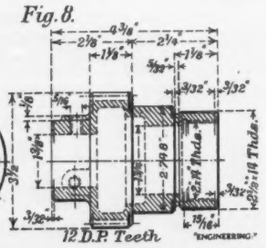
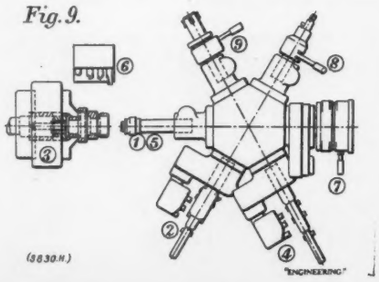


Fig. 9.



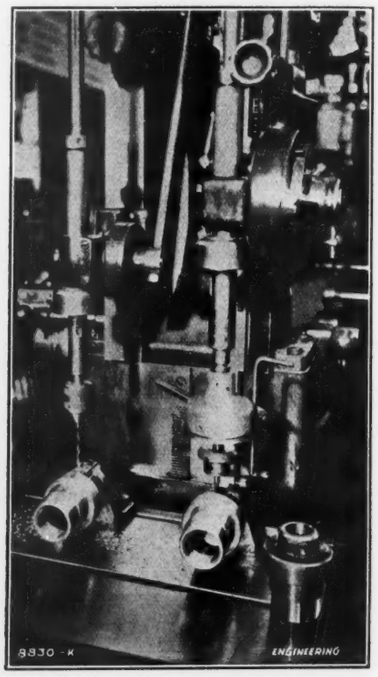


FIG. 11.

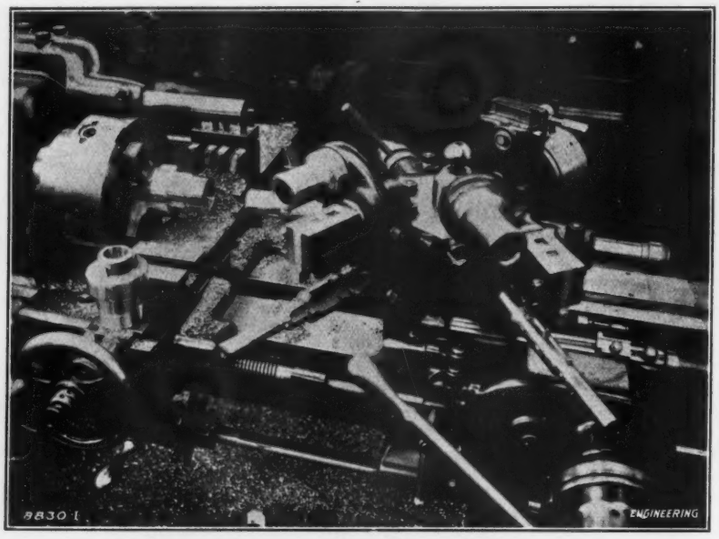


FIG. 10.

Fig. 13.

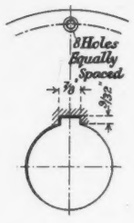
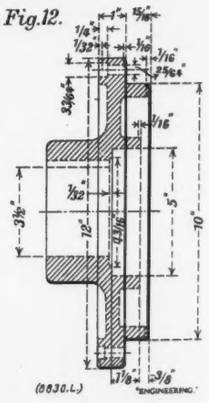


Fig. 12.



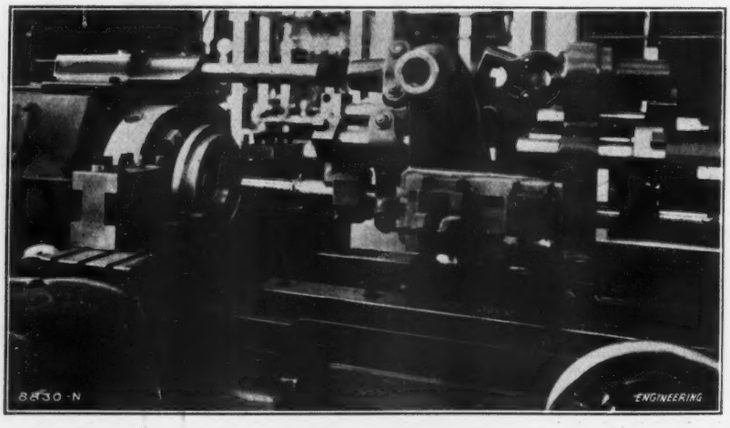
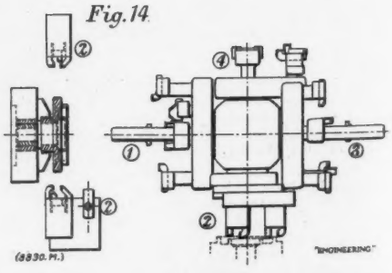


FIG. 15.

Fig. 14.



fixed to the headstock fits into a socket on the tool fixture giving increased rigidity. The headstock support can be clearly seen in Fig. 10, in which the knee tool holders and sockets are on the near side of the capstan.

The steady bar (1) was next brought into action again as the fifth operation, to give support to the work while the back facing slide (6) was brought up to it to chamfer both edges of the large diameter, face the shoulder, form the undercut between the 2½-in. and 2·748-in. diameters, and chamfer and face the end of the casting. The next capstan operation (7) utilised a 2½-in. fine-thread Coventry die head mounted in an elevating holder. The elevating holder is fitted to enable the die head to be lifted when passing over the capstan slide. The die head screwed the 2½-in. end to 14 threads per inch. By means of the eccentric recessing tool (8) the recess shown in Fig. 8 at the inner end of the 2-in. diameter was taken as the next operation, this being followed by the internal screwing of the 2-in. part to 14 threads per inch, by means of a Coventry collapsible tap (9). The whole cycle on this capstan lathe was completed in 1 min. 20 sec., all operations being done at 350 r.p.m., except the finishing of the turned and bored diameters, for which a speed of 511 r.p.m. was employed.

Subsequent to the lathe operations, the work was transferred to a Herbert two-spindle ball-bearing drilling machine, in which it was carried in jigs, and the three radial holes first drilled under one spindle,

Fig. 16.

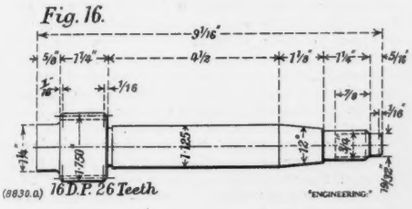
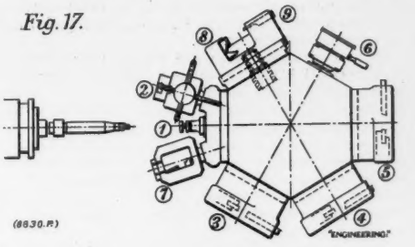


Fig. 17.



this being followed by tapping under the second spindle with the aid of a reversible tapper, giving a backing out speed of twice the tapping speed. This operation, occupying 20 seconds, is illustrated in Fig. 11. Finally, the gear teeth (40 teeth of 12 D.P.) were cut on a Fellows gear shaper in 2 minutes, the machine running at 700 strokes per minute. The whole machining time for this piece, therefore, amounted to only 3 min. 40 sec.

Figs. 12 to 14 refer to the machining of a cast-iron bearing cover. This was dealt with on four machines, including a Herbert No. 5 automatic lathe, a Heald grinder, a ball-bearing drill, and a broaching machine. The No. 5 automatic was described when first brought out at the time of the Machine Tool Exhibition of 1920 (ENGINEERING, Vol. cx, page 339). A view of the turret and overhead steadies is shown in Fig. 15. This machine was used in the case in question for turning and boring, facing and reamering. The tools of the first turret station rough-turned the 10-in. and 12-in. diameters, the boring bar roughing the 3½-in. hole, and two cutters on the head holding the bar boring and facing the 5-in. internal diameter. The recessed ring was also roughed out with a cutter on the first station. On the turret being turned to the second station, roughing and finish facing cuts were taken by two sets of tools shown in Fig. 15, on the near face of the turret. At the same time, the front and back cross slides were brought into operation to finish the 12-in. diameter on both sides and chamfer the edges. The third turret station brought finishing tools into use for the 10-in. diameter and 10-in. to 12-in. face, for chamfering the 10-in. diameter edge, finish boring the 3½-in. hole, and finishing the 5-in. counter bore and face. At the fourth station, a floating-cutter reamer provided for the accurate finishing of the 5-in. internal diameter and two tools accurately sized the 10-in. and 12-in. diameters, these cutters being fitted with very fine adjustment, so that the finished size could be obtained without unclamping the tools.

The whole cycle on the machine occupied 9½ minutes, the short time being attributable to the convenient speed and feed changes which operate on this machine, while cuts are being taken. For instance, during the rough boring and turning, the cut was started with a feed, for the 3½-in. bore, of 16 cuts per inch. As each of the other cutters came into operation, the speed was slowed down suitably, and the feed became finer until during the work on the 5-in. diameter counterbore it was 60 cuts per inch. On machines without this feature, the whole operation would have had to be carried out at 60 cuts per inch. The next operation on a Heald grinder consisted in finish-grinding the 3½-in. internal diameter, this occupying 4 minutes. On transferring to the drilling machine, the eight $\frac{3}{16}$-in. holes were drilled with one spindle, and the $\frac{3}{8}$-in. counterbores to these were drilled with the second spindle, this taking three minutes per piece. The final operation on the broaching machine consisted in cutting the keyway $\frac{5}{32}$ in. by $\frac{7}{8}$ in., this occupying 40 seconds.

The last example we propose to notice is the pinion and shaft shown in Fig. 16, turned out on a Herbert No. 11 turret lathe in 5 minutes from the solid bar, followed by 2½ minutes on a Fellows gear shaper. The length of the piece is 9 $\frac{1}{16}$ in., and the pinion has 26 teeth of 16 D.P. 1¼ in. wide. The bar used was 1$\frac{7}{8}$ in. in diameter, and of 28-ton steel. The rough bar was first fed out against a stop (1) on the triple tool holder. A step turning tool, (2) next started a 1¼-in. diameter, which was carried on by the box turning tool, (3) at a speed of 319 r.p.m. and 68 cuts per inch, leaving an

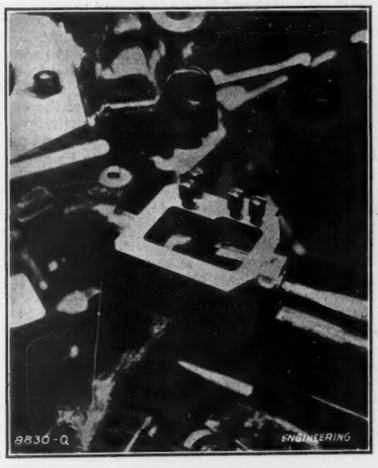


FIG. 18.

allowance of 0·010 in. for grinding. The next two operations also used box-turning tools, (4) for the ¾-in. diameter length, and (5) for the 1¾-in. diameter. The sixth operation employed a 1-in. Coventry die head which screwed the ¾-in. length to Whitworth thread. A combination holder (7) on the first face next reduced, faced and chamfered the small end of the shaft, and formed the taper between the ¾-in. and 1¼-in. lengths. At the same time the tool holder supported the shaft in a bushed hole. This fitting is shown well in Fig. 18. The final operation on the lathe, with the tools (8), consisted in forming the short 1¼-in. diameter length and chamfering both edges of the 1¾-in. diameter, by means of two tools mounted on the cut-off slide on the turret. Finally, the cutting-off tool (9) came into use to part the work from the bar. For the two last operations the piece was supported in a bush in the turret.

THREE-WIRE DIRECT-CURRENT DISTRIBUTION NETWORKS.

*Three-Wire Direct-Current Distribution Networks: Some Comparison in Costs and Operation.**

By HERBERT WILLOTT TAYLOR, Associate Member.

Permissible Current Loading.—Before proceeding to compare the various types of systems, it is necessary to form some idea of the relative carrying capacities of cables laid under different conditions. No useful purpose would be served by comparing the costs of, say, a 0·5 sq. in. by 0·25 sq. in. by 0·5 sq. in. feeder made up of single-core cables laid direct in the ground, with that of a solid-laid triple-concentric feeder of the same cross-sectional area. For this reason it is necessary to find the sizes of the various cables which will give approximately the same performance for any given method of laying.

There are so many modifying influences that affect the safe current-carrying capacity of a cable, such as the type of ground in which it is laid, the depth and manner of laying, the nature of the loads and the construction of the cable itself, that it is impossible to fix any definite values unless all the prevailing local conditions are known. Some of these points are enumerated below :—

The method of laying the cable has a modifying influence. Where a single-core cable is laid direct in the ground the problem is a fairly easy one. When one comes to consider multicore cables and, perhaps, the bunching of cables, it is more difficult to estimate the temperature rise for any given current.

With cables laid solid, the chief factor that prevents any trustworthy figures from being given, is the nature of the material used for filling in the troughing. In some cases, the thermal resistivity of this material is nearly as high as that of the cable dielectric, while in others it is considerably lower, almost equalling the value for damp earth. Until the question of the filling material has been more fully investigated, no loading tables will be available. For purposes of comparison, however, it has been assumed that for a vulcanised-bitumen cable laid solid, the maximum permissible loading will be considerably lower than for an armoured cable laid direct, and about the same as for a lead-covered cable drawn into a duct.

The chief variable quantity that renders a comparison difficult when considering drawn-in cables, is the layer of air that surrounds a cable in a duct. It is this thin layer of air that offers the greatest resistance to the flow of heat emitted from the cable and, as it may or may not be in motion, its lagging effect is very problematical. Again, the carrying capacity of a cable depends upon its heat emissivity, which is inherently bound up with its design. It is obvious that a single-core cable completely surrounded by earth at a uniform temperature will be able to dissipate the most heat.

In a triple-concentric cable, neither of the two inner cores borders directly upon the surrounding soil. This means that all the heat generated in the inner core has to pass through both of the other cores before it leaves the cable. It will readily be realised from this fact that, for a given current in all cores, the inner core will be by far the hottest, and hotter than any core in a three-core cable of the same sectional area and carrying the same current. Although the outer core, having a very good cooling surface, will operate at a much lower temperature, no advantage can be taken of this, as the safe current density that can be applied is limited by the temperature of the hottest core, which means that a triple-concentric cable will have a lower rating than either a single-core or a three-core cable.

Much very useful information on this subject is contained in the Second Report on the Research on the Heating of Buried Cables, issued by the British Electrical and Allied Industries Research Association (see *Journal I.E.E.*, 1923, vol. lxi, page 517), and, from the information given in this Report, Table I has been compiled as representing average conditions. This table shows the maximum permissible currents that can be applied to single-core, three-core and triple-concentric cables as used on a three-wire direct-current network with the three methods of laying. It should be noted that on a three-wire system the neutral conductor carries little or no current, so that the ratings can be increased above the values that would apply if all cores were carrying the same current.

TABLE I.—*Maximum Permissible Constant-Current Loading.**

Area of Live Conductors (Neutral Core Half the Size of Outers).	Cables laid Direct (Lead-Covered and Armoured).			Cables drawn in (Plain or Lead-Covered).		Cables laid Solid (Vulcanised-Bitumen)
	Three Single-Core Cables.	Three-Core Cable.	Triple-Concentric Cable.	Three Single-Core Cables.	Three-Core Cable.	Triple-Concentric Cable.
sq. in.	amps.	amps.	amps.	amps.	amps.	amps.
0·1	298	263	249	202	185	162
0·15	367	331	313	261	238	208
0·2	438	390	371	317	290	254
0·25	497	447	424	373	338	295
0·3	559	501	478	428	388	340
0·4	665	589	562	526	474	415
0·5	748	669	641	604	545	482
0·6	845	—	724	696	—	552
0·75	949	—	812	800	—	634
1·0	1,158	—	997	1,012	—	800

* The values given are for sandy loam with 10 per cent. moisture content, and clay with 20 per cent. moisture content.

Type of Cable.—When a network is first laid down it is, as a rule, only possible to anticipate the districts

* Abstract of paper read before the Institution of Electrical Engineers, on January 8, 1925.

at which the heaviest loads are likely to occur, the probable amount of load at each of these districts being too indefinite to warrant any variation in the size of the feeders. It is therefore usual to decide upon the number of nodal points that are necessary and to connect these to the station with feeders of equal size. From electrical considerations, the more nodal points there are the more efficient will be the operation of the system, but economic facts have to be faced and a compromise reached. It is well to err on the side of fewer feeders at the beginning, because, when an undertaking is young, and therefore struggling, any unnecessary capital outlay is to be avoided. Another fact that lends support to this precaution is that the natural, and most economic, nodal points for a town frequently move, owing to the erection of new buildings and the migration of people from one part of the town to another, this generally being from the centre outwards. New feeders can be laid when necessary, by which time the extra expense can better be borne, and an indication given as to the most suitable place for a new nodal point to cope with any migration of load that is taking place.

The choice of the size of cable for a feeder is more an economic than an electrical problem. This is because the question of voltage-drop on such a cable is only of secondary importance, as there are no limiting factors imposed by the Electricity Commissioners as in the case of distributors. Any variation in the value of this drop can be counterbalanced by an equal variation of the 'bus-bar voltage, so maintaining a constant pressure at the nodal points. It is therefore confined to a consideration of the heating effect of the current and a compromise between the energy lost in the cable and the capital charges. The most economical size of cable is obtained when the cost of the energy wasted, plus the capital charges for the part of the plant necessary to supply this loss and for the cable itself, is a minimum.

Single-core Cables.—From the point of view of operation it is undoubtedly the best policy to use single-core cables for feeders, as advantage can be taken of their high current-carrying capacity. It is for this reason that some undertakings have adopted such a system of feeders, even though the rest of the network is made up of three-core or triple-concentric cables. The greatest advantage in the use of single-core cables is the small amount of inconvenience caused to consumers under fault conditions, this being particularly evident when followed up by a similar type of distribution system. This point is fully considered in the section dealing with distributors.

Three-core and Triple-concentric Cables.—Between the other two types of cables there is not much to choose, any advantage resting with the three-core cable, maximum current-carrying capacity of which is rather higher than that of the triple-concentric cable. Joints on three-core cables are also simpler, but this is not so important on feeders where there are comparatively few; on distributors, however, the fact assumes much greater importance. The use of three-core cables is limited to sizes up to 0·5 sq. in., cable manufacturers being unwilling to guarantee larger sizes. This disadvantage is not shared by the triple-concentric cable.

Conduit.—In deciding the best method of laying feeders, the local conditions are always the governing factors, and these will not be similar in every case. The type of roadway met with in the centre of a town, in which area the bulk of the feeder system will generally be situated, is often of a very different nature from that in the outlying districts, and this fact might warrant additional initial expenditure with a view to future saving in the event of probable faults and possible extensions. For this reason it is often considered advisable to incur a little more trouble and expense in drawing the feeders into conduits in order to reap, at some future time, the advantages derived from such practice, amongst which are :—

(1) Rapid localisation and repair of faults. (2) Low cost of increasing the size of the feeder. (3) Saving on capital charges due to the possibility of installing a cable sufficiently large to cope with loads of the immediate future, thus avoiding burying in the ground a large quantity of idle copper which is not then required and from which no return will be forthcoming for many years. (4) Less depreciation.

The first of these points, namely, the rapid localisation and repair of faults, is vitally important, in a system of which the feeders, during certain hours of the day, are loaded almost to their utmost capacity. The ease with which a faulty length of plain lead-covered feeder drawn into conduits can be located and replaced, as compared with the amount of time spent in taking up sets and breaking through a concrete roadway foundation to gain access to a direct- or solid-laid cable, perhaps in several places before the fault is located, may prove invaluable when the other feeders are in imminent danger of suffering permanent damage due to overloading. The question of the cost of repairs is more or less bound up with the speed with which they can be carried out, as time undoubtedly means money, whether reckoned in wages or in loss of revenue.

The conduit system has the advantage that when feeders of too small a section may have been originally installed, due either to errors in calculations or to the shifting of the more heavily-loaded districts, the mistake can be rectified at a minimum cost. Advantage can often be taken of this good quality of the conduit system by intentionally installing a smaller size of cable than will ultimately be required, but which is large enough for loads of the immediate future. It will readily be seen that if, say, a 0·25 sq. in. feeder will carry all the load that is likely to be required for 10 years, after which it might be advisable to instal one of 0·5 sq. in. cross-section, there will be a considerable net saving in capital charges due to the fact that the extra cost of the 0·5 sq. in. feeder during those first 10 years when the major portion of the copper will be lying idle and bringing in no return, will not have to be met. Even this arrangement can be improved upon by drawing another feeder into spare ducts, laid at the same time as the others, the two cables then operating in parallel as one feeder. This obviates the loss that would be incurred by drawing out and scrapping the original feeder. The heavier initial cost occasioned by the increased number of ducts to be provided is only slight, particularly in the case of multicore cables. It is also conceivable that, due to the causes mentioned above, the size of the feeder might never require to be increased, the result being a permanent saving only rendered possible by letting the future take care of itself more or less.

The possible amount of depreciation is much less in the conduit system than in either of the others, because, should the cable break down, the only renewable part is the cable itself, whereas in the case of the direct- or solid-laid cable the whole cost of the mains is lost, all the original trench work and the reinstatement of the roads has to be done over again, and probably the protective material will have to be renewed. If the copper and lead of the recovered cable are sold, then the only loss will be the insulation, the cost of manufacture and the labour of pulling in and jointing the cable.

Where there are no obstructions, a depth of 2 ft. to the top of the conduit is ample; but in the main thoroughfares of a large town a depth of from 3 ft. to 4 ft., or even more, is necessary to enable all obstructions to be avoided. Such roadways often appear to the electrical mains engineer to be a tangled mass of gas, water and drain pipes with sometimes Post Office cables, tramway feeders and hydraulic mains added to thwart his endeavours to obtain a straight conduit track. It is in such roadways that the direct-laid cable shows to particular advantage, as it can be run to avoid such obstructions.

If concrete is used as a protection for the conduits, with the intention of saving them from the crushing strain of very heavy traffic, it should be laid underneath and packed round the sides as well as on the top. If intended merely as a protection from picks, it need only be placed on the top and at the sides. In either case it should have a smooth finish to enable it to be recognised by any workman opening the ground later as being there for a purpose and not to be smashed up as a casual obstruction. The concrete surrounding the conduits also preserves their alignment and renders them gas- and water-tight, thus minimising the risk of explosion or electrolysis. In the opinion of the author, the use of concrete is unnecessary unless the circumstances are exceptional.

Plain lead-covered cable and earthenware conduits should be used. Whilst braiding certainly protects the lead sheathing during drawing-in operations, and steel-wire armouring, in addition to this, takes the strain off the lead, these will rot away after a number of years in a wet duct and effectively jam the cable should any attempt be made to draw it out.

Cables laid direct.—A fact that becomes quickly apparent when considering the laying of a cable direct in the ground is the ease with which such work can be carried out. There is no need for the same amount of preliminary caution to be taken as for laying a conduit track along a main road. The fact that an obstruction is easily passed by this method is often a deciding factor in its favour.

The life of a lead-covered cable laid in good ground such as clay or sandy soil, has not yet been determined, but the fact that such cables, on being examined after 15 or 20 years' service, show no signs of deterioration, would appear to indicate that their useful life is very considerable.

For feeder work, full advantage can be taken of the high maximum permissible loading of the direct-laid cable. This might, in some cases, enable a smaller size of cable to be used than if it were to be laid solid or drawn into conduits.

Two factors have to be borne carefully in mind when laying cables direct, viz., (1) Electrolytic action due to stray currents from other sources. (2) The corrosive action of certain types of ground.

When the cable runs for a considerable distance parallel to a tramway track, a portion of the earth current may be induced to leave the track and return along the lead covering of the cable. This can be guarded against by laying the cable solid or drawing it into watertight conduits over that portion of the route on which electrolysis might be expected.

In ground largely composed of ash or slag, there is a certain amount of free sulphur tetroxide which, when dissolved by any water that happens to penetrate through, forms a weak solution of sulphuric acid. This would rapidly corrode the lead covering of a cable laid direct in such ground. The danger can be avoided by the methods mentioned above or by the importation of a quantity of clay, if such a supply is easily available, in which the cable is embedded and through which the acid cannot penetrate.

Cables laid solid.—The system commonly known as the "solid" system was introduced by Messrs. Callender's Cable and Construction Company, Limited, and marked a great advance on the methods previously employed. Practically the only occasions on which this system is used to-day is when local chemical or electrolytic action would be probable on a cable laid direct. Even when such a course is adopted, plain lead-covered cable is preferable to the vulcanized, bitumen-sheathed cable, for the following reasons :—

(1) The cost is lower. (2) The continuity of the lead sheathing is maintained where the rest of the system, following modern practice, is composed of lead-covered cables. (3) Similar cable may be used for drawing into conduits on other parts of the system, and so the amount of cable to be kept in stock is reduced. (4) Freedom from damage to other adjacent roadway works in the case of a prolonged leakage to earth. This is particularly liable to occur on single-core vulcanised-bitumen cables laid solid.

Another point against the use of even single-core vulcanised-bitumen cables is that no advantage can be taken of the special arrangement—dealt with below under the heading "Distributors"—which enables the continuity of supply to be maintained in almost every breakdown, when single-core lead-covered cables are used throughout the system.

Modern practice is to use earthernware troughs because :—(1) They are more easily laid down and better joints are possible between two troughs. (2) They are unaffected by acids contained in the surrounding ground, resulting in long life.

It is well known that all wood contains certain vegetable acids, chiefly acetic acid. If a wooden trough is laid in damp ground it will quickly deteriorate and the acid will ultimately attack the cable. It is for this reason that wooden boxes should never be used for enclosing joints.

When laying the troughing, pockets should be carefully avoided because any water that manages to find its way into the troughing will accumulate at such places and, in time, percolate through the bitumen and destroy the cable. To do this it sometimes means that a deeper trench has to be excavated than is the case when laying a cable direct, to enable the troughs to be laid underneath most of the other roadway obstructions. A depth of about 2 ft. 6 in. will generally be found sufficient for this purpose. The troughs should not be laid directly on a bed of clay when the ground above is of a porous nature, as surface water is liable to collect at such a level and perhaps find any weak spot in the troughing. In such cases it is better to deepen the trench slightly to allow the cable to be completely surrounded by clay. A foundation of some pervious substance such as loose stones or sand is beneficial, as water will quickly soak through and leave the cable comparatively dry, instead of remaining in the vicinity of the cable.

Before the bitumen is run in, it is essential to see that the troughing is perfectly dry inside. Should any appreciable amount of moisture be allowed to remain, blow-holes will be formed in the bitumen, through which, in time, water will percolate to the cable. (This is a very trying feature of solid-laid cables.) The cable is then covered with hot bitumen, which is allowed to set. The reason for having the first filling fairly hot is to make it sufficiently thin to ensure it filling up the small gap which is formed between the bottom of the cable and the trough, due to the cable resting on the saddles, and thus prevent the formation of any air spaces. It also serves the purpose of helping better to expel, before it sets, any moisture that might be left in the trough. The remainder of the trough can be filled up with bitumen at a temperature of about 250 to 300 deg. F., and if the tiles are fixed before this sets they will be held firmly in position.

Costs of Feeders.—From the figures given in Table I, a set of curves, shown in Fig. 1, have been drawn, from which the respective sizes of cables that have to be used for a given load and method of laying can

at once be determined. For the purpose of comparing the cost of the different systems for feeders, the respective sizes necessary to cope with a maximum continuous load of 500 amperes are taken as being :—

(1) Three single-core cables	Paper-insulated, lead-covered, steel-tape-armoured, laid direct	= 0·25 sq. in. × 0·125 sq. in. × 0·25 sq. in.
(2) Three-core cable		= 0·3 sq. in. × 0·15 sq. in. × 0·3 sq. in.
(3) Triple-concentric cable		= 0·325 sq. in. × 0·1625 sq. in. × 0·325 sq. in.
(4) Three single-core cables	Plain lead-covered, drawn-in and paper-insulated vulcanised bitumen, laid solid	= 0·375 sq. in. × 0·1875 sq. in. × 0·375 sq. in.
(5) Three-core cable		= 0·44 sq. in. × 0·22 sq. in. × 0·44 sq. in.
(6) Triple-concentric cable		= 0·525 sq. in. × 0·2625 sq. in. × 0·525 sq. in.

It is not, of course, suggested that where the size indicated in the above list is not a standard, a cable should be specially constructed to meet the specific requirements. As it is necessary, however, to have some definite basis of comparison, the costs of the sizes of feeders which would give the same results in practice are considered, and where these are not standard cables their costs have been calculated from those of the nearest standard sizes.

The costs of the various systems are shown for two types of roadway, namely : (1) sets on a 6-in. concrete foundation ; (2) water-bound macadam.

The depth of track required for each of these types of roadway will not always be the same for all methods of laying. Table II shows the depths of tracks allowed for in estimating the results shown in Table III.

The figures given in the latter table show that three single-core feeders are the cheapest to lay down. When this fact is considered together with the technical advantages of this type of cable, there must be very exceptional reasons to cause any undertaking, not hampered by restricted road space, to adopt a multicore cable for feeder work. It is also apparent from these figures that the cheapest way to lay cables is to lay them direct in the ground. There is little to choose between the conduit and solid systems, but both these are considerably more expensive to install than the direct system.

As already pointed out, the first cost in laying down a feeder is not the only consideration. When provision has to be made for future extensions, and when the cost of repairing faults in cables laid under certain types of roadway that are both expensive to excavate and to reinstate is borne in mind, a considerable ultimate saving will be effected by incurring the increased initial cost of the conduit system—a fact clearly demonstrated by an examination of the figures shown in Table IV. This table shows, exclusive of cable, the portion of the original expenditure that will have to be reincurred when it is necessary to increase the size of the feeder. It will also be seen that the harder the type of roadway, *i.e.*, the more it costs to excavate and reinstate, the more substantial are the benefits derived from the conduit system.

TABLE II.—*Depth of Track for Feeders.*

Type of Ground Surface.	Cables Laid Direct.	Cables Drawn In.	Cables Laid Solid.
	ft.	ft.	ft.
Sets on a 6-in. concrete foundation	2	4	3
Waterbound macadam ..	2	3	2

Apart from the cost of various types of distribution systems, the most important factor is that of continuity of supply in case of breakdown, and in this respect distributors composed of three single-core, lead-covered cables, used in conjunction with a similar type of feeder, form the best arrangement. This is because a fault can occur on one core without either of the others being affected, a rare occurrence on a multicore cable. Should one of the live cables break down, this cable alone need be cut out (provided that, by so doing, excessive load would not be thrown upon the neutral cable), the consumers connected to the other "side" being in no way affected.

A simple earthing device at the station reduces to a minimum the possibility of even this partial disconnection, and at the same time diminishes the cost of network boxes by allowing the more simple and reliable link box to be substituted for the majority of the fuse boxes (see Fig. 2). When an earth occurs on one of the "outers", it simply blows the light earthing fuse, and the neutral and the outer are, respectively, raised or lowered to 240 volts and 480 volts above, or below, earth potential, as the case may be. The system will therefore continue to operate with one of the outers earthed instead of the neutral. This condition cannot, however, be allowed to continue indefinitely, as the Electricity Commissioners stipulate that such a fault must be cleared within 24 hours. The allowance of so short a time is due to the fact that, whilst it involves no danger to the electrical system, there is a greater risk of shock from the higher potential at which the unearthed pole is then operating.

This arrangement offers no relief to the network when a fault takes place between cables, an occurrence which, though uncommon, must be provided for. For this reason it is not advisable to run the network without any fuses whatever, for should a short-circuit develop between two cables the fault must burn itself clear. During this time the cables leading up to the fault are liable to damage and the supply for the whole town is subjected to violent fluctuations of voltage. This difficulty is overcome by installing a few heavy network fuse-boxes at certain points (their exact position being determined by the layout of the particular system), in order to isolate completely the district in which the fault has occurred and allow the rest of the supply to continue undisturbed.

A point in connection with this system of earthing that should be carefully borne in mind, is that the neutral cable under normal conditions may have an earth fault without the supply being in any way affected. Should an earth then occur on either the positive or negative cable, there will be a short-circuit, varying in magnitude according to circumstances, between the two faults, and this will remain until one of the faults burns itself clear or is isolated by the operation of fuses. To guard against this possibility the neutral should, at periodical and convenient times, be raised to the potential of one of the outers through a light copper fuse, and any earth faults thus detected should then be immediately located and repaired.

Due to the fact that the potential is removed from the fault when the light earthing fuse at the station is blown, very little damage is usually done to the cable, provided that water has not penetrated through to the insulation. It is very often found in such instances that a new piece of cable is not necessary as the fault can be repaired by simply stripping back a portion of the lead covering and, after taping the damaged part of the insulation, sealing it up in a cast-iron joint box or lead sleeve. This considerably reduces the cost of making the repair.

When the actual repair of a fault on one of the cables is considered this system shows up to further advantage, because :—(1) The work can be left over, if desired, until the time when the least inconvenience will be caused to the consumers. (2) When locating the fault, only the faulty side need be disconnected. (3) The time taken to make a straight joint is very much less than with a multicore cable, and therefore the distributor can be put into commission again in a shorter time.

By employing a cable in which is incorporated a thin copper testing-strip, lightly insulated from the lead sheathing, it is possible to locate a fault without actually cutting the core, which means that there is no need to disconnect the faulty cable until the fault has been found and everything is ready for effecting the repair. In fact, if the cable is fed from both ends and it is found necessary to insert a new length of cable, this can often be done without interrupting the supply at all.

A further advantage of the use of single-core cables is that the numerous tappings taken off distributors are more simple and easy to make, and therefore more reliable. Also, when making such connections it is not necessary to make the cable dead. This fact, from the points of view both of the supply undertaking and the consumer, has beneficial results, because there is no loss of revenue during the time the connection is being made, and no inconvenience is caused to consumers.

(To be continued.)

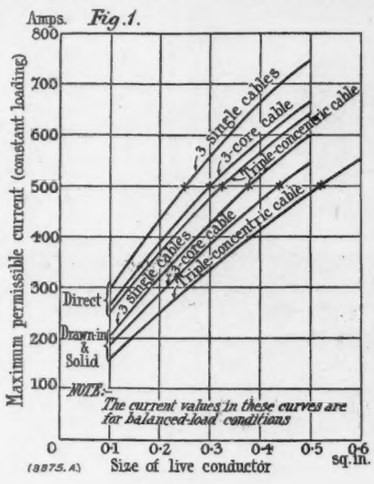


Fig.1.

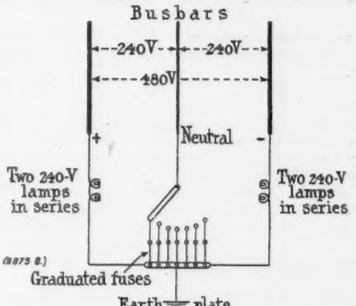


Fig.2.—Method of earthing the neutral bar at the substation

TABLE III.—COST OF FEEDERS (500 AMPERES) PER 100 YARDS.

Type of Roadway.	Lead-Covered, Steel-Tape-Armoured, Laid Direct.			Plain Lead-Covered, Drawn-in.			Vulcanised Bitumen, Laid Solid.		
	Three Single-Core Cables.	Three-Core Cable.	Triple-Concentric Cable.	Three Single-Core Cables.	Three-Core Cable.	Triple-Concentric Cable.	Three Single-Core Cables.	Three-Core Cable.	Triple-Concentric Cable.
	£	£	£	£	£	£	£	£	£
Sets on a 6-in. concrete foundation	230	238	238	308	308	320	301	309	323
Waterbound macadam ..	146	153	153	218	218	230	212	220	233

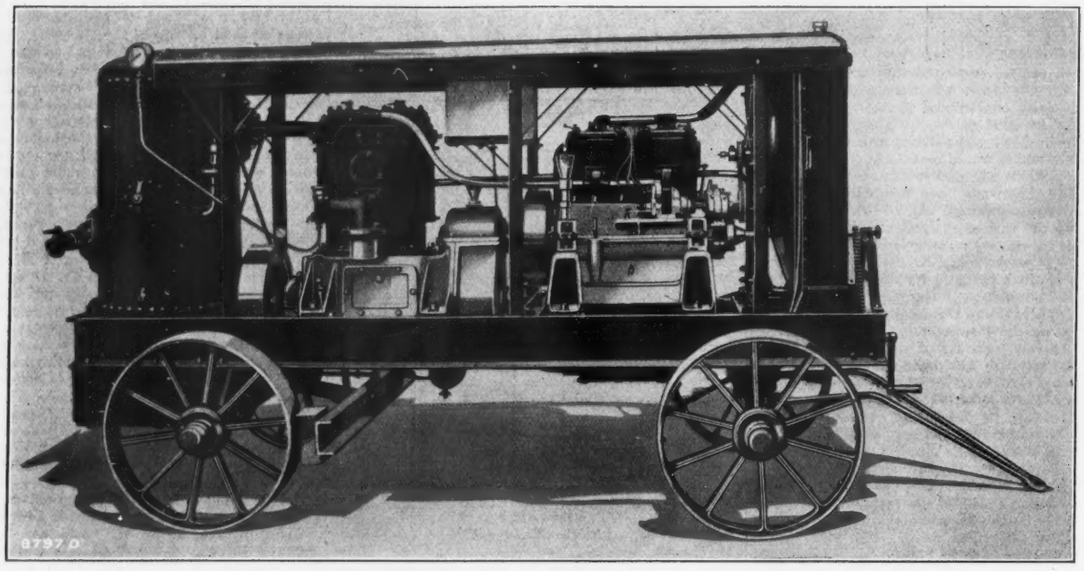
TABLE IV.—COST OF INCREASING THE SIZE OF FEEDERS PER 100 YARDS (EXCLUSIVE OF CABLE).

Type of Roadway.	Lead-Covered, Steel-Tape-Armoured, Laid Direct.			Plain Lead-Covered, Drawn-in.			Vulcanised Bitumen, Laid Solid.		
	Three Single Cables.	Three-Core Cable.	Triple-Concentric Cable.	Three Single Cables.	Three-Core Cable.	Triple-Concentric Cable.	Three Single Cables.	Three-Core Cable.	Triple-Concentric Cables.
	£	£	£	£	£	£	£	£	£
Sets on a 6-in. concrete foundation	139	128	130	19	12	14	186	167	166
Waterbound macadam ..	54	44	46	19	12	14	96	77	76

THE ROYAL SANITARY INSTITUTE.—A series of lectures, commencing each evening at 6 p.m., will be held under Part I of the course prescribed for sanitary officers at the Royal Sanitary Institute, 90, Buckingham Palace-road, London, S.W. 1, on Mondays, Wednesdays and Fridays, beginning on Friday, February 27. Amongst these lectures one by Mr. Edward Willis, M.Inst.C.E., will be on "Ventilation and Warming"; another on "Calculations, Measurements, Plans and Sections" will be given by Mr. W. C. Tyndale, M.Inst.C.E., and Mr. F. Wilkinson, M.Inst.C.E., will deliver a lecture on "Building Sites." Other subjects, such as water supply, water distribution, and sewage disposal, will be dealt with during the course.

PORTABLE PETROL-DRIVEN AIR COMPRESSOR.

CONSTRUCTED BY MESSRS. HOLMAN BROTHERS, LIMITED, ENGINEERS, CAMBORNE, CORNWALL.



HOLMAN PORTABLE AIR COMPRESSOR.

FOR rock drilling, road and concrete breaking, riveting and chipping, the use of compressed air has many advantages over other means of operation. In a workshop a general supply of compressed air is usually arranged to the places where it is needed through a permanent pipe system, but in the conditions obtaining on the average outside job it is only possible to obtain the benefits of compressed-air operated tools by the use of a portable compressor, which may be taken right up to the work. A good example of the type of machine referred to is shown in the accompanying illustration. This portable compressor is an entirely British production and is built by Messrs. Holman Bros., Limited, of Camborne, Cornwall. It is not only compactly arranged, as is apparent from the general view, but the characteristics of sound engineering design and construction are shown in the details of each of the component parts.

This portable unit is built up on a carriage made from steel channel sections and mounted on wheels. The plant consists of a four-cylinder petrol engine, with a bore of 4¼ in. and stroke of 5½ in., which drives through gearing a two-cylinder single-acting air compressor, which has a displacement of 134 cubic feet per minute. For storage purposes a steel cylindrical receiver is used and a fan is fitted to draw air through a radiator, erected at the other end of the chassis, and so cool the jacket water for both the air compressor and the petrol engine.

The petrol engine has the cylinders cast in pairs and side by side induction and exhaust valves are used, which are operated by adjustable tappets. Steel stamped connecting-rods are fitted, and they have die-cast white metal linings at the big ends and a phosphor bronze bush at the top for the connection to the gudgeon pin, in accordance with good modern practice. Three piston rings are used, one of which serves to hold the gudgeon pin in place. The camshaft is mounted in three bronze bearings and carries an eccentric for operating the oil pump. For the drive of the camshaft, silent chains are used. The crankshaft is a solid drop forging which is provided with oil throwers at each end, and is supported in three white-metal and bronze bearings, which receive their lubrication direct from a plunger pump bolted in the bottom half of the crank-case. This pump has simple steel ball valves.

The forced-lubrication system for the bearings is arranged so that the escaping oil is caught by the chains and lubricates the governor and water pump bearings, which are fitted with scoops to catch the oil thrown off the chains. All the oil at the finish returns to the oil troughs for the splash lubrication of the big ends and pistons. The carburettor is of the Zerith type and the ignition is effected by the use of a high-tension magneto. To facilitate the starting of the engine, a clutch is fitted in the transmission system to the compressor, which comes into operation and takes the drive smoothly as the engine gets under way.

Suitable speeds for economic working of both the engine and the compressor being required, a single-reduction gear drive is arranged in which use is made of a Fabroil pinion with its shaft mounted in double-row ball bearings at each end. The air compressor has its two cylinders cast in one block, and the cranks are set at 180 deg. to obtain good balance of the reciprocating parts. As the crankshaft has bearings which are two part adjustable and are in the end covers of the crank-case, it may be removed without taking out the pistons or connecting rods.

The cylinders are water-jacketed, and the detachable cover, which houses the delivery valves, has a large water space for cooling purposes, so that the temperature of the delivery valves, as well as the air itself, is kept as low as is possible. Troubles due to valve breakages have been eliminated through the use of this arrangement. For each cylinder there is a suction valve in the piston and a delivery valve, already referred to, in the cover above. The air therefore flows into the cylinder at the foot and passes out at the top. Large inlet ports for air are arranged in the lower part of the cylinder, through which the air is drawn and passes through valve ports in the head of the trunk piston under the Holman plate valve to the top of the cylinder. These valves are made of thin sheet steel and have portways through which the air can pass when the valve is in its open position. They are entirely automatic in action and, being arranged so that they cannot rotate, always bed properly in the same place. As large valve ports are used, the lift of the valves is kept very small. One advantage of having a plate inlet valve in the piston is that when the piston moves downwards the free inlet valve tends to remain behind owing to its own inertia, and thus the vacuum in the cylinder during the admission stroke is very much smaller than would be the case with any other arrangement. Simple helical springs are used in the delivery-valve system, and perforated plate stops are used in both cases. It will be obvious that the whole arrangement of this compressor permits the use of very simple cylinder castings, as the usual ports are entirely dispensed with. For the inspection of the delivery valve it is only necessary to take off the cover above it, which necessitates the removal of five nuts. When this is done the piston-head is visible, and the removal of a single nut, holding the suction valve in place, enables the withdrawal of the entire inlet-valve system.

For a portable compressor it is necessary that the lubrication system should work quite automatically and that it should be possible to run for a long period without attention. In this plant a gear pump is used, for which the two gear wheels are mounted in mesh in a suitable shaped chamber in a small cover at the foot of the gear-case. This pump is driven by chain from the crankshaft. Oil is delivered by it at a pressure of 6 lb. per square inch to a system of copper pipes conveying it to the main bearings and through the hollow crankshaft to the big-ends of the connecting rods. It then passes up through the connecting rods to the gudgeon-pins.

The air receiver is made of steel plate, and is fitted with a safety valve, a pressure gauge, and a drain-cock. As the air consumption varies continuously in the usual work to which these sets are applied, a control valve is fitted, which regulates the intake of air to the compressor and is operated by the pressure in the air receiver within a range of 2 lb. per square inch of the set position. Adjustment to other pressures is possible at any time. The radiator is made of aluminium and has vertical tubes fitted with gills. The cooling water is circulated by the pump attached to the petrol engine, and is first sent through the jackets of the compressor and then through those of the petrol engine before it returns to the radiator.

The plant described is a standard one, and others similar but with either 50 per cent. less or greater capacity are also manufactured. The smallest set is capable of working one of the concrete breakers or hammer drills made by the manufacturers, and the others are capable of twice and three times this service respectively, with ample margin.

RECENT MOTORSHIP TRIAL.—Some particulars of a steel motorship, built and engined by Messrs. Swan, Hunter and Wigham Richardson, Limited, at Neptune Works, Newcastle-on-Tyne, which has just completed a successful trial trip are of interest. The vessel is about 370 ft. in length and 51 ft. in breadth, and has been built under the special survey of Lloyd's Register for their highest class. She is a single-deck vessel, rigged as a two-masted ship, and is designed to carry about 6,600 tons deadweight. A centre bulkhead is fitted to permit of the vessel carrying grain in bulk: ventilation and arrangements for coal cargoes are also provided. The propelling machinery consists of a four-cylinder set of the builder's well-known "Neptune" marine oil engines of 1,500 brake horse-power. It is of the reversible two-cycle single-acting and port-scavenging type. The engine can be operated by one man from the control station on the lower platform. An interesting feature of the design is that the scavenging pumps are placed at the back of the engine, and are driven, together with cooling-water pumps, bilge pumps, and lubricating pumps, by means of levers from the engine crosshead. Sea water is used for cooling, and the water joints are arranged so that they are not exposed to the heat and pressure of the combustion gases. A special feature of the engine is that the piston is fitted with an inner casting ensuring effective cooling and easy accessibility for cleaning. Oil fuel is carried in a cross bunker, and in part of the ship's double bottom, the remainder of the latter being adapted for carrying water ballast and water for feeding the donkey boilers, two of which are fitted for the auxiliary machinery, which comprise a steam windlass, steam steering gear, and nine steam winches, together with a complete outfit of derricks, &c.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

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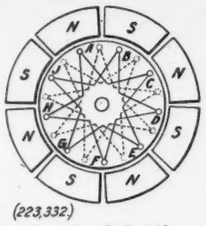
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS.

223,332. W. A. Benger, Guiseley, Leeds, and F. and A. Parkinson, Limited, Guiseley, Leeds. Induction Motors. (3 *Figs.*) July 28, 1923.—The invention relates to the construction of a rotor suitable for use with a stator whereof the winding is so arranged that for starting it will provide a field having a number of poles which is different from the number of poles used for normal running. According to the invention, the rotor conductors are connected at one or both ends by connectors so that the pitch is slightly more or less than twice the pole-pitch of the starting poles and is approximately equal to the pole-pitch of the poles for normal running, whereby the rotor winding has a high resistance for starting and a low resistance for running. The stator is shown as having eight poles for starting, and the windings are re-arranged to give six poles for running.



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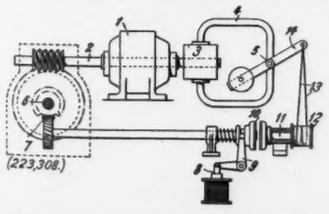
For simplicity, it is assumed that there are nine rotor slots containing conductors marked, respectively, A, B, C, D, E, F, G, H, J. Instead of using a squirrel-cage winding, the end ring at one end is replaced by connectors having a pitch of 1 to 3 as shown, this being slightly less than twice the pole pitch for the eight-pole arrangement. It will be seen that the current in the rotor bars H, A and C, which are each opposite a north pole, has to flow through several of the connectors before reaching the corresponding bars G, J and B, which are opposite south poles, and will therefore be at opposite potential. When the stator winding is re-arranged to give six poles, each conductor will be directly connected to a conductor which is under an opposite pole, since the winding pitch is nearly equal to the pole pitch; the motor will thus run as a normal squirrel-cage motor. (*Accepted October* 29, 1924.)

LIFTING AND HAULING APPLIANCES.

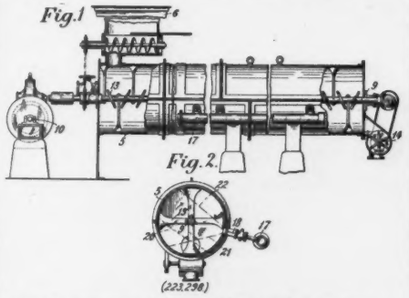
223,308. Smith, Major and Stevens, Limited, Northampton, and P. H. Stevens, Northampton. Lifts. (2 *Figs.*) July 18, 1923.—The invention relates to braking devices for electric or belt-driven lifts. 1 is an electric motor on the shaft 2 of which a hydraulic pump 3 is mounted. The pump 3 is of a type that can be driven in either direction without affecting its operation. The exit side of the pump is connected directly to the return side so that when the pump 3 is running, the oil freely circulates without any substantial work being done. In the pipe 4 is interposed a throttle valve 5, which is normally open and allows a free passage to the liquid. When the lift cage reaches a point in a predetermined relationship to the floor at


(223,308.)

which it is desired to stop automatically, this throttle valve 5 is closed gradually and completely, producing a smooth deceleration and accurate stop. The closing of the valve 5 is effected by a train of gearing between the shaft 6 of the hauling drum or wheel on the winding mechanism and the spindle of the valve 5. The gearing for operating this valve 5 is only coupled to the shaft at the moment of cutting off of the current. The effect is that the motion of the hauling wheel shaft 6 through the train of gearing 7 closes the valve 5, and traps the liquid in the closed-circuit pipe 4 when the cage has travelled the predetermined distance which has been settled to give comfortable deceleration with a smooth and accurate stop. A solenoid 8 is connected to a bell-crank lever 9, which operates a clutch 10, for connecting the train of gearing 7 to an auxiliary shaft 11 carrying a pulley 12. The latter carries two oppositely wound cords 13, which connect to a counterbalance lever 14 for operating the valve 5. When the cage has arrived at the predetermined point where deceleration is required to commence, the breaking of the current releases the solenoid 8, thus permitting the clutch spring to operate the clutch 10 and causing the hauling wheel shaft 6 to communicate motion to the auxiliary shaft 11 and pulley 12, and thus wind one or other of the cords 13 around the pulley 12 and progressively rock the counterbalance lever 14, thus gradually closing the valve 5. The gradual closing of the valve reduces the speed of the hydraulic pump 3 at any predetermined rate of deceleration, which may be adjusted as required by the construction of the valve 5 and the proportion of the counterbalance lever 14 which operates it. On remaking the circuit in an electric lift, or on shifting the belt in a belt-driven lift for restarting the machine on its next journey, the valve 5 is automatically opened simultaneously with the closing of the switch or movement of the belt striker, because on the release of the clutch 10 following the making of the circuit, the counterbalance weighted lever 14 returns to its normal position and rotates the shaft 11 back to the position shown. (*Accepted October* 29, 1924.)

MINING, METALLURGY AND METAL WORKING.

223,298. J. R. Sterling, London. Heating or Drying Apparatus. (3 *Figs.*) July 17, 1923.—The invention relates to heating or drying apparatus employing a gaseous heating or drying medium and of the type in which the material to be treated is propelled by a screw or other conveyor through a conduit into which the gaseous medium is admitted. Apparatus of the aforesaid type having a rotary conveyor operating with a horizontally-directed conduit is, according to this invention, characterised in that the injection means for the gaseous medium are so disposed as to direct the latter across the conduit on to that area upon which the material tends to accumulate during the operation of the conveyor. The apparatus comprises a cylindrical conduit 5 supported horizontally. The material to be treated is fed into a hopper 6. A shaft 9 extends centrally through the main conduit 5. The shaft 9 is driven from a cross shaft 10. The means for conveying the material along the conduit and for agitating it therein comprise a plurality of radial blades 13 bolted to the shaft at their inner ends and at their outer ends extending almost up to the inner cylindrical wall of the conduit. The wet material enters the conveyor conduit at the left hand thereof, is propelled along the conduit, and on reaching the discharge end is removed by way of a rotary valve 14 driven from



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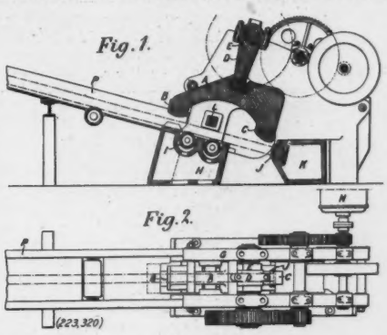
the main conveyor shaft 9. The heating medium employed is high-temperature low-pressure steam. The steam is supplied from a manifold pipe 17 extending lengthwise along the outside of the conveyor conduit. Spaced apart along the manifold are branch pipes or injectors 18 which deliver to the interior of the conduit through apertures in the cylindrical wall thereof. Each branch pipe 18 is separately controlled by a stop-cock so that the steam supply in one or more of the branch pipes may be shut off if required. Consequent upon the rotation of the conveyor, the material under treatment tends to be heaped up on one side of a central vertical plane through the conduit—the side at which the material accumulates depending upon the direction of rotation. In Fig. 2 the accumulated material is indicated at 20, the direction of rotation of the conveyor being shown by an arrow. The branch pipes 18 are arranged to deliver the steam issuing therefrom in two diverging jets 21, 22. The lower jet 21 is directed across the conduit and impinges directly upon the accumulated material 20. The upper jet 22 issues across the conduit above the accumulated material, and it operates to prevent condensation of the moisture extracted by the lower jet 21. In this way the maximum effect from the heating medium is obtained. (*Accepted October* 29, 1924.)

223,320. J. R. Lamberton, Coatbridge. Breaking Pig-Iron. (2 *Figs.*) July 21, 1923.—A machine made according to the invention and for breaking a pig-bar, or a series of them at one time, into pieces of the required sizes comprises essentially an anvil over which the bars are successively fed singly or in groups, means for stopping the bars with their ends overhanging the anvil or with their ends upon a secondary anvil and a pivoted moving head or tup adapted to hold the pig-bars on the anvil and also to break off the overhanging ends of the bars. The pivoted tup A has a holding-down head B and a breaking head C. It is carried by a connecting rod D from a crankshaft E. The anvil H lies flush between the housings G, and flush with its face are two anti-friction rolls I. A stop J encountered by the entering end of the bar (indicated by chain-dotted lines) is carried on a stool K between the housings G. A transverse bar L, also between the housings, is provided to prevent the tilting of the final end of the bar when it has become too short to be hed down by the head B. The crankshaft E is driven from an electric



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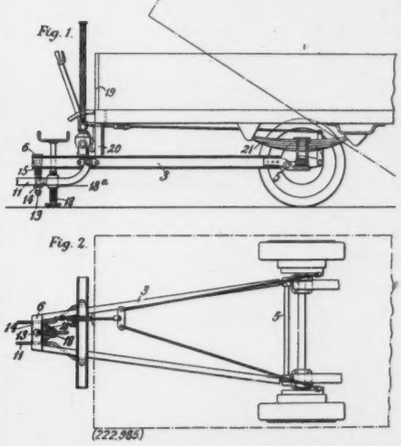
motor N. The bars are fed to the machine by way of an inclined shoot P. In operation, the bars fed from the shoot advance until their ends encounter the stop J. When the tup A descends, its head B first encounters the bar and holds it upon the anvil. Thereafter the head C, continuing to move, encounters the bar between anvil and stop and breaks off the end, which falls to a pit, whence it may be removed mechanically or otherwise. The tup then rising, the bar moves on until its end again encounters the stop J, to be again broken off when the tup descends. (*Accepted October* 29, 1924.)

MOTOR ROAD VEHICLES.

222,985. The Eagle Engineering Company, Limited, Warwick, and C. H. Cox, Warwick. Two-wheel Trailers. (2 *Figs.*) July 19, 1923.—The invention has reference to two-wheel trailers for use with tractors, and has for its object the construction of a trailer wherein the trailer body is relieved of the draught stresses and in which the initial stresses that obtain on starting and stopping are damped. The draw frame is built up of two longitudinal members 3 connected at their rear ends to a transverse rod 5. The bars 3 converge at their forward end and are secured to a plate 6. The ends of a draw bar 11 are pivotally connected to the



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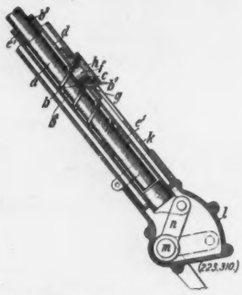
converging longitudinal members 3. Pivotally secured to the plate 6 is a bolt 13, part of which passes through an aperture in a plate 14 secured to the sides of the draw-bar 11. Between the upper surface of the plate 14 and the head of the bolt 13 and surrounding the bolt, is a coil spring 15. A nut 18*a*, secured to a bridge piece carried by the draw-bar, serves to carry a screw jack 18 for supporting the fore part of the trailer wagon when uncoupled from the tractor vehicle. The body 19 of the trailer wagon is supported at its forward end on a transverse baulk 20 mounted on the frame 3 and at its rear end the body has laminated springs 21. (*Sealed.*)

223,310. H. E. Egerton, London. Steering Gear. (2 *Figs.*) July 18, 1923.—The invention refers to steering gear for mechanically-propelled vehicles, and, according thereto, the steering gear comprises a cam in the form of a helical screw-thread or worm with vertical or steeply-inclined faces, and a roller working in the groove thereof between the faces, the roller being guided so as to move up and down parallel to the axis of the cam as the latter is rotated. On the steering column *a*, is a cam *b* in the form of a portion of a helical screw-thread with vertical or steeply-inclined faces b^1, but preferably with the grooves b^2 thereof of larger width than the threads so

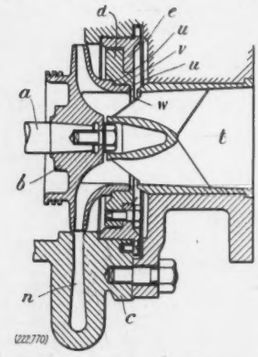
as to accommodate in diameter a roller *c* with its periphery bearing on the side faces b^1 of the threads. The roller *c* is guided so as to move up and down parallel to the axis of the cam *b* as the latter is rotated. The roller *c* is itself mounted on an axis at right angles to the axis of the cam *b*, and it is conveniently guided and maintained in this position by means of a sleeve *d* surrounding the cam *b*, and of such a length that ample bearing surfaces which take their bearing upon the cam *b* or upon end portions or extensions b^3 thereof can be employed. The threads constituting the cam may conveniently comprise one, two or more complete turns, leaving on each side thereof a free or smooth portion of the tube upon which are adapted to work bearing bushes d^1 on the sleeve *d* guiding the roller *c*. The sleeve *d* and its bearing surfaces are made sufficiently long, so that



any wear which may take place is so far distant from the roller *c* that its effect upon the roller itself will be small, or, in practice, negligible. The roller *c* is provided with bushes or sleeves *f* of considerable length, which are supported between the brackets or in end bearings in a housing *g* formed upon the sleeve *d*, the roller *c* being made readily detachable by means of a movable plate or cover *h*. The housing *g* moves in a slot in the outer tube *k*. In practice, the outer tube *k* of the steering column conveniently terminates in, or is secured to, a casing *l*. The rocker shaft *m* takes its bearing transversely in the lower end of the casing *l* and has a short arm or crank *n* arranged within the casing to which the lower end of the sliding sleeve *d* is connected. (*Accepted October* 29, 1924.)

PUMPS.

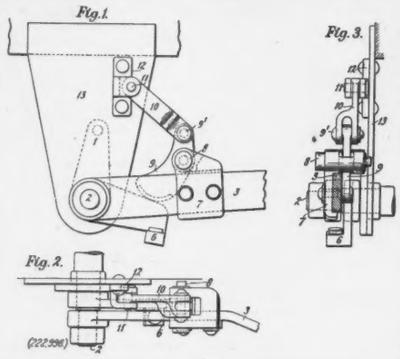
222,770. G. and J. Weir, Limited, Cathcart, Glasgow, and W. McCowatt, Cathcart, Glasgow. Centrifugal Pumps. (2 *Figs.*) March 22, 1924.—The invention consists in the provision of a cylindrical packing and steadying ring with two or more restricted and adjustable end clearances which function like labyrinth packing. This ring may be fitted at either side of the impeller. *c* is the pump casing and *t* is the suction inlet to the pump. *b* is the impeller mounted on the shaft *a*; it draws water from the suction inlet *t* and delivers it to the chamber *n*. *d* is the packing and



steadying ring, which is formed with one cylindrical surface *v* and two restricted end clearances *u*. The suction end *w* of the impeller is formed with cylindrical and radial surfaces to co-act with those on the ring *d*. It will be seen there is a steo-like arrangement of contact surfaces and end clearances with decreasing diameter in the direction of flow of the escaping fluid. The ring *d* is held in place and adjusted in a direction parallel to the pump shaft by means of a member which is threaded and screwed into the pump casing and locked by means of a pin. (*Sealed.*)

RAILWAYS AND TRAMWAYS.

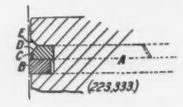
222,998. Meboe, Limited, Westminster, London, and J. C. G. Cossey, Golders Green, London. Hand-operated Brake Levers. (4 *Figs.*) July 27, 1923.—The invention relates to hand-operated brake levers of railway vehicles of the type in which a given angular movement of the free end of the hand-brake lever, pivoted upon a brake shaft, imparts a larger angular movement to a brake-operating arm on the brake shaft, by means of a cam or lever pivoted to the hand-brake lever and engaging with an arm by which this increased angular movement is transmitted to the brake-operating arm. 1 is a lever connected to the pull rods operating the brakes, and 2 the brake lever shaft on which the long hand-brake lever 3 is loosely journalled. A short lever 6 is keyed on the shaft 2. A casting 7 is riveted to the lever 3 and carries on its laterally-extended and forked upper part a pin 8 on which is pivoted a cam 9, to the upper end of which is pivoted at 9′ the forked end of a link 10. The other end of the link is journalled on a pin 11 mounted in a bracket 12 riveted to a hanger 13 secured to the under frame of the vehicle. The hanger 13 also supports the brake shaft 2. The cam 9 is in the



same vertical plane as the lever 6 and the disposition of the parts is such that, in the normal position of the hand lever 3, the free curved base of the cam rests on the upper surface of the lever 6. As the hand lever 3 is depressed for the purpose of applying the brake, the cam, owing to its connection with the pivoted link 10, rotates about the pin 8 and imparts through the lever 6 an angular rotation to the shaft 2 and, consequently, to the brake lever 1 which is considerably greater than the angle moved through by the hand lever. (*Sealed.*)

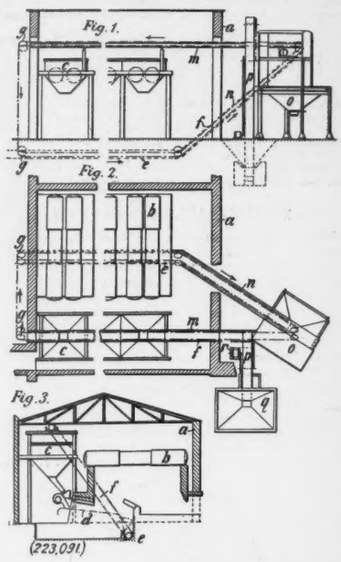
STEAM ENGINES, BOILERS, EVAPORATORS, &c.

223,333. William Beardmore and Co., Limited, Dalmuir, and R. Love, Dalmuir. Piston-Packing Rings. (2 *Figs.*) July 28, 1923.—The invention relates to packing rings for pistons. According to the invention, there is interposed on the pressure side of the packing ring an additional ring of smaller external diameter than the internal diameter of the cylinder. The recess or groove A provided to hold the usual packing ring B is made up of such dimensions as will allow the insertion in the groove, on the pressure side of the ring B, of an additional ring C. This ring C is of smaller external



diameter than the internal diameter of the cylinder, and is so formed that it tends to spring inwards. The outer corner D on the pressure side of the ring C and the edge E of the groove are bevelled so that the pressure fluid acting on the peripheral surface of the ring C assists it to embrace and make joint with the bottom of the piston groove and also forces it axially against the surface of, thus causing it to make joint with, the adjacent packing ring B, with the result that the pressure fluid is effectively prevented from finding access to the back of the ring B and unduly forcing it against the cylinder wall. (*Accepted October* 29, 1924.)

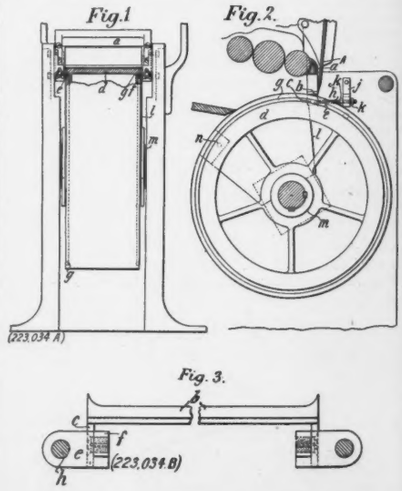
223,091. The Underfeed Stoker Company, Limited, London, and E. W. Robey, London. Handling Coal and Ashes. (8 *Figs.*) December 28, 1923.—In a boiler house having a number of furnaces of such kind that coal and ashes are automatically delivered and discharged in a manner involving movement of the coal and ashes on lines which are not in the same vertical plane, two conveyors are generally necessary, one for distributing coal to coal bunkers and another for conveying away ashes discharged from the furnaces. By this invention a single conveyor is constructed to perform both operations. The boiler house *a* contains a battery of boilers *b* and a row of bunkers *c* for feeding fuel to the travelling grates *d* (Fig. 3) by means of which the boilers are fired. The clinker and ashes from the travelling grates are discharged into a water trough *e* common to the whole battery. In order that the same endless conveyor chain *f* may serve both purposes before stated, it is essential that the plane passing through both runs of the conveyor should be inclined, and, for economy of construction and power, the chains of the conveyor travel also in this plane in passing from the lower run to the upper run at one end of the conveyor (Fig. 2). It is thus necessary that at this end the axis of the sprocket wheels *g* over which the chains run, and also the axis on which each scraper is carried by the chains, should be inclined so as to be substantially at right angles to the said plane. In order to avoid the complication of altering this inclination of the axis of the scraper in the horizontal portions of the path of the conveyor, the plane of the track is inclined to the same angle throughout the path where a track is necessary. The travel of the conveyor being that indicated by the arrows, the scrapers carry the ashes up the inclined portion *n* of the conveyor, also contained in a trough, until the ashes fall over the end of the trough into the hopper *o*. The scrapers then turn over the sprocket wheels and enter the trough *m*, into which coal is dumped by a conveyor *p*, fed from a



hopper *q*; this coal is carried along by the scrapers to fall into the appropriate bunker *c* as determined by a temporarily opened discharge gap in the bottom of the trough. The conveyor *p* is driven by the motor *r*. (*Sealed.*)

MISCELLANEOUS.

223,034. O. Legg, London, and Robert Legg, Limited, London. Tobacco-Cutting Machines. (5 *Figs.*) September 21, 1923.—The invention relates to tobacco-cutting machines of the type in which a knife at the end of its cutting stroke shears past a hardened steel cutting strip. The cutting knife A passes a mouthpiece *a* and hardened cutting strip *b*. At the ends of the cutting strip *b* are tongues *c* which project down between the sides of the mouthpiece *a* and a feeding drum *d* which is reduced in width to allow for these tongues. Attached to each tongue *c* is a block *e* having a projection *f* which slides in grooves *g* at each side of the drum *d*, thereby ensuring that the cutting strip *b* is always in contact with, and resting upon, the face of the drum *d*. To each of the blocks *e* is attached



a screw *h*, each screw passing through a slot in brackets *j* attached to the right and left-hand frames of the machine. The screws are retained in position by nuts *k*, which grip both sides of the brackets *j*. Adjustment of the position of the cutting strip *b* is obtained by loosening and tightening up alternately the nuts *k*. As the feed drum is reduced in width, a space occurs between the drum and each side of the feeding trough through which tobacco would fall. To obviate this, two plates *l*, each being the segment of a circle and of the same diameter as the drum, are pivoted on bosses *m* on the centre of the drum and are prevented from moving by bolts *n*. The segments *l* are of sufficient thickness to fill the spaces caused by the reduced width of the drum. (*Sealed.*